PROCEEDINGS

CONFERENCE FOR MOBILITY TRAINERS AND TECHNOLOGISTS

sponsored by the

SENSORY AIDS EVALUATION AND DEVELOPMENT CENTER, M.I.T.

M.I.T. FACULTY CLUB

December 14 & 15, 1967


EX
LIBRIS

PROCEEDINGS

CONFERENCE FOR MOBILITY TRAINERS AND TECHNOLOGISTS

sponsored by the

SENSORY AIDS EVALUATION AND DEVELOPMENT CENTER, M.I.T.

M.I.T. FACULTY CLUB

December 14 & 15, 1967

ACKNOWLEDGEMENTS

The Sensory Aids Evaluation and Development Center wishes to espress its appreciation to:

The Rehabilitation Services Administration of the Department of Health, Education and Welfare for their support of the conference under Contract SAV - 1057 - 67;

The Hartford Foundation for additional support;

The International Research Information Service of the American Foundation for the Blind for issueing these proceedings;

All the participants in the conference for giving so generously of their time and knowledge.

PARTICIPANTS

James J. Acton
St. Paul's Rehabilitation Center
770 Centre Street
Newton, Massachusetts

Loyal Eugene Apple
Chief of Blind Rehabilitation
Veterans Administration Hospital
Palo Alto, California

Thomas Benham
Department of Physics
Haverford College
Haverford, Pennsylvania

J. Malvern Benjamin
Bionic Instruments
221 Rock Hill Road
Bala-Cynwyd, Pennsylvania

Norman Berube
Sensory Aids Center
292 Main Street
Cambridge, Massachusetts

Larry E. Blaha
California State College at Los Angeles
5151 State College Drive
Los Angeles, California 90032

Donald Blasch
Center for Orientation and Mobility
of the Blind
Western Michigan University
Kalamazoo, Michigan 49001

Murray Burnstine
Sensory Aids Center
292 Main Street
Cambridge, Massachusetts

Terrence Clark
California State College at Los Angeles
5151 State College Drive
Los Angeles, California 90032

George Dalrymple
Sensory Aids Center
292 Main Street
Cambridge, Massachusetts

MaryAnn DeLuca
Perkins School for the Blind
Watertown, Massachusetts

Ross Duffy
810 Mulvane
Topeka, Kansas

John K. Dupress
Sensory Aids Center
292 Main Street
Cambridge, Massachusetts

Robert A. Eisenberg
California State College at Los Angeles
5151 State College Drive
Los Angeles, California 90032

Emerson Foulke
Psychology Department
Belknap Campus
University of Louisville
Louisville, Kentucky 40208

Howard Freiberger
Research and Development Division
Prosthetics and Sensory Aids Service
Veterans Administration
252 Seventh Avenue
New York, New York 10001

Alex Glimcher
Sensory Aids Center
292 Main Street
Cambridge, Massachusetts

William Goodman
916 West Park Street
Florida State University
Tallahassee, Florida 32304

Mary Hoffman
The Industrial Home for the Blind
57 Willoughby Street
Brooklyn, New York

James A. Kimbrough
5331 Centre Avenue
Pittsburgh, Pennsylvania

Robert LaDuke
Center for Orientation and Mobility
of the Blind
Western Michigan University
Kalamazoo, Michigan

J. Alfred Leonard
Nottingham University
Nottingham
ENGLAND

Paul McDade
Fernald School
Boston, Massachusetts

David J. McGowan
Board of Education and Services for the Blind
170 Ridge Road
Weathersfield, Connecticut 06109

Hazel Moore
Special Services for the Blind
University Station
Grand Forks, North Dakota

Gerald W. Mundy
New York Association for the Blind
111 East 59th Street
New York, New York

William Murphy
New Jersey Commission for the Blind
1100 Raymond Boulevard
Newark, New Jersey

John L. Parrish
Department of Special Education
Teachers College
Columbia University
New York, New York 10027

Kathryn Reilly
Perkins School for the Blind
Watertown, Massachusetts

T.J. Rey
Weston Instruments
17 Hartwell Avenue
Lexington, Massachusetts

Robert Richards
Department of Special Education
San Francisco State College
1600 Holloway Avenue
San Francisco, California 94132

Lawrence Rosen
Beltone Electronics
4201 West Victoria
Chicago, Illinois 60646

Lindsay Russell
Sensory Aids Center
292 Main Street
Cambridge, Massachusetts

E.F. Shaw
Beltone Electronics
4201 West Victoria
Chicago, Illinois 60646

Frederick Silver
Boston College
96 College Road
Chestnut Hill, Massachusetts

W. R. Smith
Boston College
96 College Road
Chestnut Hill, Massachusetts

Stanley Suterko
Center for Orientation and Mobility of the Blind
Western Michigan University
Kalamazoo, Michigan 49001

McAllister Upshaw
Metropolitan Society for the Blind
1401 Ash Street
Detroit, Michigan 48208

Hugo Vigoroso
Boston College
96 College Road
Chestnut Hill, Massachusetts

William Walkowiak
Boston College
96 College Road
Chestnut Hill, Massachusetts

Marvin Weessies
Association for the Blind
934 Cherry Street
Grand Rapids, Michigan

Lloyd Widerburg
Center for Orientation and Mobility of the Blind
Western Michigan University
Kalamazoo, Michigan 49001

Russell C. Williams
Veterans Administration
Department of Medicine and Surgery
Washington, D.C. 20420

Burdell Wurzburger
Department of Special Education
San Francisco State College
1600 Holloway Avenue
San Francisco, California 94132

TABLE OF CONTENTS

PREFACE

John Kenneth Dupress died on December 29, 1967, two weeks after chairing the Mobility Conference described herein, his last official act as Director of the M.I.T. Center for Sensory Aids Evaluation and Development. His sudden and totally unexpected passing is an irreplaceable loss to the search for effective sensory aids, and immeasurably saddens his many friends and colleagues who worked with him, or cheered from the sidelines, as grudging progress was made in relating the burgeoning knowledge and resources of our day to the needs of the blind.

John's motivation and drive was Herculean, and his vocational talents and avocational charms many. But these Proceedings stand as another example of Mr. Dupress's special capacity to identify problems and organize for their eventual solution. He combined forthright and sensitive delineation of a profound human deprivation with interdisciplinary recruitment of people from technology, psychology, and rehabilitation who could contribute to its amelioration.

This first Mobility Conference evoked the formation of a Committee on Orientation and Mobility which brings together knowledgeable and experienced practitioners in these fields to work in consort. One can't help but reflect on John Dupress's mid-wifery in the formation some five years ago of a somewhat similar blend of talent in the Braille Research Committee and Conferences. Before he died John, never a complacent sort, could take some pleasure in the significant progress made in the development and demonstration of enhanced communication for the blind, using computer-based braille production systems. He no doubt hoped, and planned for, a similar systematic attack upon, and progress toward resolving the tougher problems of enhanced blind mobility. We can best memorialize John Kenneth Dupress by unrelentingly pursueing goals he set.

Robert W. Mann
Chairman, Steering Committee

DEVELOPMENT OF MOBILITY PROGRAMS WHICH USED CANES AS AIDS

Russell C. Williams*

When Mr. Dupress invited me to talk on this subject we agreed that it should not be confined simply to dates and places. We agreed that what was to be attempted should include factors which caused such programs to start, and the short and long-range results flowing from them.

Histories on blindness and stories containing references to blind people, which I have read, make me believe that staffs and cane-like aids have been used by blind people to help in their mobility for centuries. I have wondered how these people came to use a staff as an aid in their travel. How many conceived of it themselves and how many had its value suggested by someone else. In any case, I remember nothing which would indicate that there were any teaching programs for the purpose.

In France, before their Revolution, an early educator of the blind outlined his finding that it was not until a number of blind were brought together that their educational needs emerged with significant clarity. Nothing suggests that a mobility program using canes came out of this period. Later, in the 1870's, W. Hanks Levy, writing in England, described clearly and with feeling the advantages to blind people which could come out of improved mobility skills. His writing also suggests that no mobility teaching arrangements existed and that he was appealing for something of this nature.

In 1910, Dr. Edward Allen, American educator of the blind, extolled, in a report of his observations on a visit to Germany, the formal teaching of the blind in everyday living skills and techniques which he had seen there. Dr. Allen stated, and he would have known, that no such teaching was going on in the United States. He did not mention mobility, but even if he had seen teaching of it in Germany, it would only have been mentioned as one of the skills not taught in the United States. In no place in the reports on St. Dunstan's have I seen any reference to mobility teaching, let alone teaching it with canes as aids. I cannot recall having read or heard of any stress on mobility in the World War I servicemen's blind rehabilitation program at Evergreen.

The United States had gone quite a way into World War II before it settled the where and how of rehabilitation of its war blinded. By the time things got under way, there were significant numbers of blinded servicemen collected

---

* Chief, Blind Rehabilitation, Veterans Administration, Department of Medicine and Surgery, Washington, D.C.

together at the Army's Dibble General Hospital, Valley Forge General Hospital, Avon Old Farms Convalescent Hospital, and the Naval Hospital in Philadelphia. All of these places had some unusual factors prevailing. All of the blindness was new. A freedom to try new things prevailed in the war and armed service atmosphere of the time. The blinded servicemen were generally healthy enough to be active physically. Their blindness confined them to inaction. The radical change in the men's circumstances, from great physical activity and self-dependence to forced inaction and dependency, called for some real imagination from those in charge of blind rehabilitation programs. All four of the armed services hospitals were imaginative in their blind rehabilitation programs, but only one of them developed a mobility program of any lasting consequence and in that one, Valley Forge General Hospital, the cane was the key aid in the process.

Key program personnel at Valley Forge premised their actions on their stated belief that blind people traveled poorly. These personnel had extensive experience with blind people, prior to their Army responsibility, on which to base this opinion. Having this belief, and feeling relatively secure from the effects of possible sniping criticism from the field of work for the blind, they explored ways by which they might improve the independent traveling abilities of blinded servicement.

It was readily accepted that canes were helpful aids in the mobility of the blind. It is to Valley Forge's credit that they did not allow their imaginations to start by throwing out as an instrument, the cane, which had demonstrated its usefulness to blind people for so long. Instead they set about finding out how it could be more effectively used and how its used could be taught. Out of their imagination came a "touch in front" method of cane use which added efficiency. If this method had been used by blind people before, the instances were rare.

To get a "touch in front" system going required a longer than usual cane. Added length meant added weight, so canes of metal were secured which could be long and yet light. For the system to be efficient the departure of holding the cane in the front center of the body, rather than at the side, was made necessary. Specially selected and trained staff taught cane use in graduated learning situations developed inside and outside the hospital.

Besides the special canes and instructions for using them which became part of the orientation and mobility process for blinded servicemen, Valley Forge developed another important factor. Respect for the cane as an aid, and for the self-dependent mobility of the blind in which it plays such an important part, was caused to permeate the feelings of personnel all over the hospital and, in a less but still significant way, in the community of which the hospital was a part. This respect

for the cane as an aid which was accorded by hospital administration, professional services, and citizens in the nearby community was, I believe, as important to the short- and long-range success of mobility at Valley Forge as the different cane, different usage and the teaching involved. Never, to my knowledge, did the environment of Valley Forge indicate to a blinded serviceman that he was respected less because he used a cane to help him with his orientation and mobility problems.

The other three rehabilitation sites for blinded servicemen of World War II also showed much respect for independent mobility of the blind. They stressed its importance and encouraged its development for the servicemen in their programs. None of them, however, accorded respectability to the cane as an aid in this skill. Their failure to do so caused servicemen there to finish their rehabilitation with negative feelings about the help a cane could give, and of people who used them.

When the Armed Services closed their rehabilitation programs, the Veterans Administration commenced. Hines began its mobility program with the benefit of the legacy of validation from Valley Forge. Unusual cane length and out of the ordinary ways of holding and manipulating it had demonstrated clear-cut values, and the beneficial effects of a supporting environment could be counted on. Over the years HInes added refinements to the cane and the teaching methodology involving it. Hines' respect for the cane's value in mobility of the blind, and for the blind person who used it well, was so strong that at times it generated some ill will from some in the field of work with the blind. You may be sure, though, that it strengthened the self-respect of the veterans who learned to use the cane at Hines.

Not very long after Hines got under way, it began to have visitors from organizations serving blind people, who wished to see what it was doing in mobility with the cane as an aid. The visitors came from the United States and abroad and stayed for periods ranging from one day to six weeks, to observe the part mobility, which used the cane as an aid, played in the rehabilitation process. Hines felt responsible to help these visitors observe as thoroughly as possible but it worried that some of the visitors might be misled into thinking that they qualified as instructors in mobility only on the basis of these observations.

When Hines had been going for awhile, persons from Foundations and Universities whose responsibilities were to coordinate and administer educational programs for teachers of blind children, secured the help of Hines' instructors to demonstrate orientation and mobility principles and programs. These instructors helped in summer schools, year after year, at Universities in many parts of the United States. Here again it was not intended that teachers attending these courses be considered mobility instructors as a result of them, but rather that they obtain

a better understanding of what mobility really involves, how it can be promoted, what objectives are attainable, and what kind of a supporting role it would be well for them to play with their students.

Hines made a movie, intended to show the growth and development of a blinded man in a Blind Rehabilitation Center environment. Mobility lent itself well as the modality vehicle which would show this best. After nearly fifteen years this film is still requested, from places all around the world, by people who say it does much to help create an understanding of the work involved and the pleasure derived from mobility achievement, and the role which the cane plays in the process.

Toward the end of the 1950's, work for the blind in this country focused enough requests for trained instructors in mobility that the Vocational Rehabilitation Administration and the American Foundation for the Blind arranged a meeting of knowledgeable people to see how to meet these requests. Among other things, educational and personal qualifications for mobility instructors were enunciated. Following this, the VRA gave Boston College support, which enabled it to start training instructors in their graduate school. Western Michigan University followed suit shortly thereafter also with VRA support.

As graduates emerged they were employed by schools and service agencies for the blind. A lot had to be learned by the employing organizations, such as how to use the knowledge of the mobility instructor, and how to fit him into their existing educational and service programs. Demonstration Grant support by the VRA helped a lot in getting to and over this hurdle.

By now there are probably more than 325 mobility instructors, employed full or nearly full-time, in orientation and mobility programs in the United States, which use the cane as an aid. There are also a number in Europe and Asia who came out of the training programs in this country. The cane is being used in the mobility training that is being given to children and adults, some of whom retain useful sight and some of whom do not. Some of those helped are elderly and others are very young. Some have illnesses and disabilities in addition to their blindness.

The cane, and its place in the mobility of blind people, has come a long way in twenty-five years. The canes are better and the value in their use much better understood. Their place in the overall orientation and mobility processes are clearer. The feeling that one depreciates himself by using a cane as an aid is not nearly so pronounced as it used to be, and has become less of a block to the mobility of blind people.

EXPANSION OF MOBILITY TRAINING TO CHILDREN AND AGED

Donald Blasch*

It has been pointed out that initially the programs were set up to train students primarily to work with the productive blind adult population, usually adventitiously blind. In fact, most of our experiences, which served as the basis in developing our present techniques and skills, were with this type of client. Prior to the establishment of the formalized training programs that now exist at the university and college levels, Hines personnel served as instructors at a number of workshops to acquaint teachers and other rehabilitation personnel with the skills and techniques that they were using at the V.A. Hospital. At these workshops, it was found many of the techniques employed by blind adults were equally applicable to blind children and this was further substantiated by our experiences in working with blind children in the Chicago area.

Subsequently, the Social and Rehabilitation Service of the Department of Health, Education, and Welfare, and the Office of Education provided grants to establish orientation and mobility programs in school settings. Grants were given in Illinois, California, Florida, and Kansas in public school settings. Others were given to residential schools in Massachusetts, Arkansas, and other states. Most of these programs were highly successful and the resistance that some of us anticipated never really crystalized. At the present time, over 45% of our graduates are employed by schools, either residential or public, and I would venture to say that 80% of our graduates work with children at some time or another. I am sure that this is equally true of Boston graduates. I am not familiar with the duties of graduates of other schools, but I believe their trend is similar.

There are, of course, many adjustments that the instructors had to make in dealing with children. Although the skills and techniques were basically the same, the method of presentation, the building of experiences and concepts

---

* Director, Blind Rehabilitation Programs, School of Education, Western Michigan University, Kalamazoo, Michigan.

that correlated with the reality of the environment and, in many cases, corrective exercises to improve gait, posture and body concepts were necessary to ensure a meaningful orientation and mobility program for the student. Most of the students were congenitally blind, and although it would appear inconceivable that educational programs could develop without including this service to the students, the fact remains that prior to the development of the present training program of mobility instructors, very few schools had formalized training in this area. It is gratifying to see that most of the educators are eager to correct this mistake. Working with blind children seems to have a special appeal to most of the graduates; not only does it present a challenge that they welcome, but probably, just as important, they can see tangible results of their efforts. Most of them are aware that our tremendous technological and medical advancements can be helpful in formulating a new approach for the total education of the blind through a multi-discipline approach. Research and improvements in aids for the blind are continuing and many show promise of being helpful in limited areas if they are properly used. By proper use, I mean training the blinded individual to use the aid effectively and efficiently and to have him realize its limitations. I am afraid that far too often we fail miserably in this area, and an effective device is discarded needlessly or is used only by a limited few. On the other hand, we hear of exaggerated claims of how much an aid can help a blind individual. A case in point is the news article on Dr. Armando Del Campo's amauroscope. These claims are usually based on controlled laboratory experiments and limited field testing, usually evaluated by people who are not knowledgeable in what is involved in this type of activity for blind individuals. Nevertheless, the more means by which we can increase the sensory input to an individual and teach him to correctly interpret it (for no interpretation leading to meaningful concept formation will develop spontaneously), the better he will be able to function. This remains true regardless of the number and kinds of gadgets and techniques that are developed. In the end, the type and amount of stimuli they provide will improve and degrees of success will be achieved, and there is no doubt that the younger clients will make better adaptations to aids.

Recently Dr. R. Scott published an article in which he claimed that 90% of our services to blind were directed to one-third of our blind population. If there is any foundation for this claim, most of it must come from our neglect of the aged blind. With our increased population (over 200 M) and increase in our life span (over 70 years), there is a corresponding increase

in the numbers over 65 (19 1/2 M). Incidents of visual impairments among the aged are much more frequent, and those over the age of 65 represent at least 50% of our blind population, yet they probably receive less than 10% of the services offered. Relatively little has been done in the area of orientation and mobility with this group, but in the few cases where efforts have been made in this area, the results have been gratifying. The goals, of necessity, are more limited and the progress is slow; the aging processes negate the chances of maintaining a constant level of performance. Effective training will help them to better maintain their self-esteem by increasing personal and physical independence and allow them to operate more effectively in their chosen environment.

The physiological factors that we have to deal with in addition to diminishing vision are: (1) diminishing hearing, (2) diminishing pain sensitivity, (3) diminishing sense of balance, (4) diminishing of ability to adapt to changes in temperature, (5) diminishing of perception of movement of body, (6) decline in muscular strength, (7) decline in cell growth and repair, (8) decline in capacity for continuous exertion, (9) decline in information gathering and interpreting functions, and (10) decline in ability to perform tasks requiring sensory motor integration, memory, discrimination, decision making, attention span and capacity to be conditioned. The lack of motivation is another factor that must be considered. These people are approaching the end of the continuum of the life cycle and it is more difficult to instill motivation in this type of client. But, in spite of all this, the ability to learn continues although at a much slower pace. Aids that present stimuli too rapidly or require quick responses, plus the fact that they are unfamiliar, have less chance of succeeding with this group, but they should not be ruled out completely as we still have a wide range of individual differences here.

Perhaps due to the fact that progress comes so slowly and the goals are limited, the majority of mobility instructors are reluctant to work with this age group. Perhaps the fault lies in the fact that we have not attempted to make work with this age group more attractive and challenging to the students. Perhaps the type of people we need to work in this area should have characteristics and qualifications that are different. Whatever the reason is, we should concentrate our efforts on providing this group with services and aids that have been denied them and that they can use to make their remaining years more meaningful.

BASIC TECHNIQUES ESSENTIAL TO ORIENTATION AND MOBILITY

Lawrence Blaha*

Orientation and mobility involves the blind person's ability to know about his environment and to move more freely and purposefully because of specific techniques attained through instruction and application. Orientation and mobility techniques are fundamental activities that are involved in every phase of every blind person's life. They open up possibilities for learning, reality-grounded conceptualization, exploration, achievement, and personal independence not available in any other basic acitivity.

The more meaningful and integrative the initial basic orientation is to the environment in terms of training, variety, and quality of experience, the better will be the total development of the individual and his command of his environment.

Therefore, the desire to know more about objects and phenomena as they exist in part and as wholes must be awakened and encouraged in our clients using all remaining senses as well as vicarious experiences and comparison. Only through meaningful stimulation and experiences will these needs be met adequately.

Basic Techniques are orientation and mobility areas encompassing the use of orientation skills, concept development, sensory training, hand and arm protective skills, selected techniques of daily living and selected social skills. There are indications that there is insufficient time devoted to these techniques and often a de-emphasis of Basic Techniques in the orientation and mobility training of blind persons.

This is not to be misinterpreted that less attention should be given to the touch cane technique, to the dog guide or to the electronic device. In fact, skills gained in Basic Techniques are a foundation and strength to be used in many phases of advanced travel.

These Basic Techniques have often been referred to as pre-cane techniques. The implication is merely that they are generally taught before the blind person's cane instruction. But the term pre-cane has often been misinterpreted as something you learn before you received the cane and not used after you began to function with it.

---

*Director, Department of Special Education, California State College at Los Angeles, 5151 State College Drive, Los Angeles, California.

We should take time to analyze the number of hours per day that a blind person is not called upon to travel independently with a cane or dog or an electronic device. The number of hours in social activities; the number of hours in decoding the immediate surroundings; the number of hours in which only Basic Techniques are employed.

How much in life is confined to hand and arm techniques? To controlling an environment; to the functioning in a sphere of operations that can be reduced into the dimensions of several square feet.

Basic Techniques must be presented to each individual client in a systematic step-by-step procedure at a ratio of one instructor to one client.

In a span of several minutes I have mentioned the term Basic Techniques six or seven times. What are they? What specifically am I referring to? Well, obviously the Sighted Guide, Forearm Technique, Trailing, Squaring Off, and Direction Taking.........To say these are Basic Techniques is to imply that mobility is grasping a cane at or near the handle, thrusting one's arm forward and swishing the cane back and forth in front of him in some type of in-step manner and proceeding to walk from Joe's place to John's place, and from John's place to Joe's place. Now that you have permitted me a moment of frivolity, let's examine the subject in its entirety.

Basic Techniques are the area for beginning to think of broad connotations of orientation. It is more than being able to follow a pattern, a definite route. Orientation implies being able to relate that route to a larger environment. An aim of orientation is to teach the individual to relate so that he can replicate different to-and-returning-from routes. As this develops we begin to see travel, to see a basis for transfer of learning. It is in the Basic Techniques area that we begin to build the foundations for the more complex travel skills to follow.

It is in this area that the individual ceases to function in a vacuum, ceases to function within a tunnel, acquires access to restricted places.

I realize we do not have the time and it probably is not the purpose here this morning to present a curriculum and methodology of basic techniques. But, briefly, a consideration of some examples of where Basic Techniques play an important role in the life of blind people should be examined.

Earlier I asked how much time is spent in movement without a cane, thus requiring use of basic or pre-cane protective and information gathering techniques. In actuality, it is true that for the majority of people their daily activities involve movement about their home, their business facility

and work area, church or fraternal building, school or other indoor environments. Outdoor travel using a cane or other device is possibly more complex and certainly has more potential dangers, but it is far less time consuming than indoor activity.

In each indoor situation the blind person is observable by sighted people whose attitudes and responses to him can be positively or negatively affected by his performance. It seems reasonable to assume that a blind person would enhance his prospects for being repeatedly invited to participate in social activities of his friends, neighbors, and organizational associations if he is able to rapidly organize his concepts of spatial relations of objects about him and move with a high degree of efficiency and grace. If anxiety over his safety and the safety of articles around him can be reduced to a minimum or alleviated, his social image will be substantially improved.

Similarly, in school or business situations his ability to learn rapidly where things are and how to move more efficiently, as well as safely, can greatly affect the response of professors, counselors, advisors and prospective employers.

In a job situation a person's security may be dependent in part on the degree of proficiency with which he moves about his work area, or between his work area, and the other parts of the facility.

With the previously mentioned statements in mind, let us look at two specific groups of blind individuals, the very young and the very old, and evaluate how basic techniques may benefit them.

In evaluating and or assessing the orientation and mobility potential of any blind person, the motivation and need factor must be considered. Often, in terms of extended independent travel, this factor is lower in these two particular groups. Their aspirations and responsibilities are less and the scope of their physical environment is somewhat constricted. A purpose and end result of thorough training in Basic Techniques is to raise the motivational level and assist the individual in achieving a more independent functional level within his environment.

How many young children have we seen whose movement is awkward and hesitant? Who have poor balance and demonstrate poor posture and gait while moving? The number of youngsters that are unable to demonstrate knowledge of right and left? Right and left as it pertains to their body, to the body of another person, to a wall they can touch, to a wall feet away, and to a street one block away? I know you have had similar experiences with this concept and concepts such as behind, straight ahead, intersection, etc. The list becomes quite long and varies from person to person.

How many children, or for that matter adults, spend a substantial amount of time in an environment, such as a classroom or office, and are not aware of the relationships of the parts of the room or objects within the room?

What of the majority of the aged who may not achieve or need a high level of independent travel skills? They still must function within their environment. If we can provide systematic and effective methods for functioning within their environment, we have met their needs.

Basic techniques can and should embody skills which provide a blind person with methods for independently and systematically exploring new environments and developing proficient, efficient mobility with the greatest ease and in the shortest time.

I should like to impress upon you that Basic Techniques are more than protective hand and arm procedures. It is the beginning of the development of orientation and mobility skills. It is the foundation which ultimately determines the structure to follow.

In conclusion, I would like to say that I am looking forward to this afternoon's agenda. From the presentation of the mobility aids, I would like to learn of their contributions as information gathering tools. I would anticipate that it will not require much imagination to foresee the role of these devices in the area of Basic Techniques.

LONG CANE TRAINING: ITS ADVANTAGES AND PROBLEMS

Stanley Suterko*

In view of the two specialty groups that make up this audience, I chose to approach the analysis of Long Cane Training as I believe the technologists would do it. I shall therefore consider it a "system comprised of three component units." By analyzing these units for their strengths and weaknesses, I hope to point out the inherent advantages and problems. And, hopefully, the technologists can bring their knowledge to bear on the problems. Before getting into this specific discussion, I feel it pertinent to make some general comments concerning the adaptability of this type of training for all of the blind.

As you heard this morning, this system has been used over the years with children, youth, and the aged adults. What was not mentioned, however, was its successful use over the years with the multiply handicapped blind. I have seen the Long Cane used by the mentally retarded blind, arm amputees, lower leg amputees, arm and leg amputees, double hand amputees, blind with profound hearing losses, and perhaps the most severely impaired were several blind persons with double hand amputations and a profound hearing loss. A number of individuals in this latter group had Krukenbergs performed on one of the stumps. I merely bring these out to emphasize the overall adaptability of the Long Cane system. I believe I can truthfully say this system has served, and can serve,greater numbers of blind than any other independent means of mobility that we have today.

Now to address myself to the title of this talk: Long Cane Training As a System: Its Advantages and Problems. In analyzing mobility with the Long Cane as a system, I view it as three distinct units: Unit one would be man; unit two would be the cane, or as I would prefer to view it, a perceptive tool; unit three would be the manner in which the tool is employed, or the scanning method.

As I look at this first unit, MAN, I can't help but be impressed with his contribution and influence on the success or failure of the whole system. There is no doubt in my mind that he is the key unit -- he not only contributes to the system but also governs or, should I say dictates, the contributions of the other two units. To a great degree, I feel that it is through man that we are able to improve any one unit or all three units of this system. Conversely

---

*Assistant Director, Institute of Blind Rehabilitation, Western Michigan University.

any inherent limitations or failures in man are not easily overcome by improving the other two units.

It is also my belief that the inherent structural limitations of the perceptive tool, or inherent deficiencies of the scanning method, can be minimized to a large extent by resourceful application of man's ingenuity.

I envision man's importance so strongly that I would state he is the key unit whether we employ a simple mechanical device as the typhlostaff, or whether we progress to the more complex and sophisticated electronic devices which generally demand a greater interpretation of the display.

It comes as no surprise then when I say Long Cane training methodology focuses on man as the catalyst to achieve a maximum merging of the units for the optimum functioning of this system. Let me briefly try to illustrate how this objective is achieved. Sophisticated locomotive behaviour by the blind demands emphasis on two distinct but inseparable elements, orientation and mobility. Orientation is defined as the process of establishing one's relative position in the environment. Mobility is defined as the locomotion of the individual from one place in space to another. Purposeful mobility, then, can only take place when properly oriented. This idea is well expressed in Fuller's quotation: "The fool wanders, the wise man travels."

This orientation aspect is accomplished through all of the remaining sensory channels so that sensory training is vital and basic to each and every mobility training experience. The senses which the practitioners focus their training efforts on are:

1. Hearing - which includes sound localization, sound shadows, echolocation, and ambient sound information.
2. Tactual - the extended tactual sense by means of the cane, soles of the feet, and thermal cues.
3. Kinesthetic (proprioceptive) sense - the detection of gradients, lateral tilts in surfaces, and estimating distances.
4. Vestibular - the detection of degrees of turns, veering, and gradients.
5. Smell - more of an area of discrimination and not quite as important as the others.
6. Vision - I include this because of the number of individuals possessing residual vision. I might add that this information may be good or bad (e.g. the case of the individual who is unable to see a greater distance than five feet attempting to use vision to determine if a car is coming up the street.

He certainly should be using his hearing which would tell him much sooner.).

7. Taste - I have listed it here though I have reservations about its contribution to mobility.

In addition to the sense training, I would say mobility training should provide opportunities to learn skills and techniques which can be applied to specific environmental situations regardless in what town they may be situated. An illustration of this is traffic light controlled intersections. The principles learned in coping with traffic lights should be applicable in Chicago as well as Kalamazoo.

All of the above mentioned items are taught according to progressively structured lesson plans. These need to be designed so initial training begins with relatively simple physical environments and simple sensory cues, progressing to geographically more complex environments inundated with a maze of sensory cues.

In trying to enumerate the problems encountered with this unit, namely, man, I would take all of the time allotted to this conference and then some. The problems encountered with man are as numerous and varied as there are individuals undertaking instructions. However, for illustrative purposes, I shall briefly try to generalize some of the more common problems the practitioners have to cope with.

1. Lack of motivation by the individual.
2. Congenitally blind - lack of adequate concepts concerning the physical environment.
3. Newly blind ; acceptance of his condition and sense training.
4. Aged adults - a deterioration of the senses, motor skills, balance, etc.
5. Fear and anxiety in non visual locomotion and its resultant exclusion of available cues.

This list could certainly go on and on. Some of these problems no doubt could be minimized through the concerted efforts of the hard and soft scientists. I would, however, hope that in solving some of these problems, it would not be at the sacrifice of man's inherent abilities. More specifically I question equipping man with a comprehensive environmental sensor that provides a continuous and highly complex auditory display that will exclude a number of auditory cues which he is able to receive with the unaided ear.

I would also like to make a few comments on the problem of straight line walking. In this area we have not fully explored the contributions bio-mechanical principles can provide to the enhancement of linear mobility

for the blind. An illustration of this is the control and movement of the line of gravity to specific mobility situations. Should the situation demand linear movement whether it be indoors to a specific objective, or outdoors in crossing a street, the proper shifting of one's center of gravity will tend to ensure success. In tasks demanding linear movement, one needs first to formulate in the mind a point of destination, or a line of travel. This is done tactually or through audition, or what would be preferable through both means as the two sources of information would verify each other. The next process would be the execution of this straight line travel.

To minimize angular deviation, I usually have the person shift his center of gravity ahead so that he begins to fall forward. Concurrently he then steps out placing his foot in the midline of the body. This coupled with an authoritative step tends to eject him on a straight line. With the usual widths of streets 25-30 feet, I expect no greater lateral deviation than this. A consistent deviation in this amount would indicate a failure which needs remedial work in one of the sub skills of this task.

Another application of the shifting of the center of gravity is the approach to drops such as stairs and curbs. An intelligent traveller when negotiating an area indicating a drop ahead, such as a curb or stairs, will unobtrusively shift his center of gravity toward the heels. This will ensure for him a controlled and quick stop.

I attempted to point out in the above two illustrations of the important role bio-mechanical principles can play in assisting the blind in their locomotion. It would be my hope those individuals studying and knowledgeable in this area would assist us in overcoming some of the problems confronting us.

The cane as a perceptive tool is a fairly simple but well designed instrument to enhance sensory input in sufficient time which enables the person to employ proper motor behavior. This behavior may be anything from a slight course alteration to a complete stop. This tool provides information to the user through the tactual sense, proprioceptors, and audition.

Some of the more common problems inherent in the cane and ones which the technologists could perhaps assist in alleviating are:

1. The length of the cane makes it impossible to put it in the pocket when not in use. A big breakthrough would occur if a cane could be designed to fold into the pocket without sacrificing any of the cane's present characteristics.

2. A cane tip either through design or material that will further minimize sticking in pavement irregularities such as cracks, joint lines, etc.
3. A hand grip that will insulate against low temperatures yet retain high conductive qualities for vibration transference to the hand and fingers. Also the design of a hand grip for the smaller hands of children and girls.
4. The weight of the present cane does not especially present problems. However, I would like to see the weight reduced from its present ten to twelve ounces to say six ounces. Perhaps an investigation of some of the newer space program metals may be our answer.

Scanning Method

As I'm sure everyone present knows, there is a specific scanning method to be employed with the long cane. This was designed by Dr. Hoover and for suggestive reasons to the user, I think it better called the "touch technique." This scanning method in reality is a representative surface sampling of the path ahead. I consider this a broad spectrum scanning method intended to cope with the needs of most situations encountered. Very briefly, the advantages of this scanning method are:

1. It can be learned by young and old with no undue difficulty.
2. It is reliable in detecting objects within one's foot path -- tricycles, parking meters, lamp posts, etc.
3. It will detect stairs, curbs, holes, and other drops with accuracy and reliability.
4. It enables the user to discriminate between different surfaces such as cement, macadam, gravel, clay, etc.

One of the deficiencies with this scanning method is that it does not do all of the things mentioned with maximum effectiveness. Saying this another way, there are other scanning methods that will do some of these detections with greater effectiveness than the touch technique---thus the development of the "touch and slide" and the "touch and drag" techniques for use in specific geographical areas.

Touch and Slide

In this technique, the cane tip remains in contact with the surface for a fraction of a second longer than in the touch technique. This coupled with the forward movement of the body and slight lateral movement of the cane tip, produces a cane tip track of about 30° laterally to the walking

path. This altered or revised scanning method is far superior in detecting stairs, curbs, and surface changes which are perpendicular to one's travel path. Another excellent application of this technique is in areas where the sidewalks blend into the streets, and one needs to accurately discriminate surface textures.

Touch and Drag

This method is designed to acquire more information from a contour line which is parallel to one's travel path. Basically the cane tip track is much more perpendicular to the travel path than in the regular touch technique. Two of the areas in which this may be applied are large gas station driveways, and across parking lots. In spite of these altered scanning methods designed to more effectively cope with specific areas, our greatest problem is in the detection of objects that hang down to the waist. Large flat surfaces can many times be detected through audition, but the narrow surface objects as street signs, low tree branches, and angular guide wires on telephone poles are extremely difficult to detect. Fortunately these situations are not as numerous as everyone tends to imagine.

I would hope the members of the technology group knowledgeable in search or scanning systems would study our present scanning method and perhaps come up with further alterations as to how the present method may be further improved.

And, it is rather obvious that the long cane and its scanning method will never fully scan the complete space through which the body traverses. This problem, then, is in need of additional devices that will selectively scan the unsearched area, that is, from the waist up, or the development of a device that will scan the complete body area including step downs.

Before terminating, I would like to say, in mentioning the above problems, I do not mean to imply that no previous studies have been made in these areas. I am fully aware of the commendable efforts of Mr. Dupress at the Sensory Aids Evaluation and Development Center, and Mr. Dufton at St. Dunstan's Technology and Research Department in their investigations of many of the problems. However it is my hope that in the future, the practitioners will be afforded the opportunity to sit down with the technologists for an exchange of ideas, so that we may achieve greater fruition.

THE CANE AS A CHANNEL FOR THE COMMUNICATION OF INFORMATION

Emerson Foulke*

I have two objectives in speaking to you this morning. First I want to describe the results of an experiment involving different kinds of canes. Secondly, I want to describe a long range research project relating to that system, the ingredients of which are the cane, the user of the cane, and the environment in which the user operates. My introductory remarks will doubtless seem obvious to this audience, but I offer them as a sort of context for what follows.

The term "cane" is a misnomer. As the term is generally understood by society at large, the cane is a tool used for support. Of course, the blind man uses the cane as a probe for the purpose of collecting information about the environment through which he is moving. This situation undoubtedly developed because, before specialized information collecting tools had been developed, the conventional cane came closest to fulfilling this need and was therefore made to serve in this capacity. But it was an adaptation, and along with it came the name, that, by common understanding, describes the tool used by a lame person for support. It probably would be better if we had a different, more descriptive, and less ambiguous term for the tool the blind man uses to gather information from his environment since use of the word "cane" encourages a misunderstanding of the tool's proper function. Be that as it may, the term "cane" is by now generally accepted as the appropriate name for the blind man's tool as well, and I'm sure that there is at least no misunderstanding of its significance in the present company.

In studying the cane, I have been interested in trying to find some way to make a quantitative evaluation of different canes, so that decisions can be made about the superiority of one cane over another. In doing this, I have chosen to regard the cane as a channel for the transmission of information. Viewing the cane in this way suggests that information is transmitted from the environment to the user by means of the cane and if the amount of information transmitted by the cane can be determined, one is in a position to evaluate, to choose among canes in terms of hopefully relevant factors. In order to do this, a task is needed that can be quantitatively assessed. The performance of the user, in relation to the cane, must be measurable. With this information, one can specify

---

* Department of Psychology, University of Louisville, Belknap Campus, Louisville, Kentucky 40208.

the amount of information, in bits, that is transmitted by the cane. The task chosen for the pilot experiment reported here was an admittedly simple one, but one which, I hope, bears some relation to the cane user's overall task. One of the things a cane user may be called upon to do fairly frequently is to detect differences in the surface characteristics of the terrain over which he walks. This detection is often accomplished by means of the cane. It is, of course, a simple matter to provide surfaces that are different, and I chose to do this by selecting four grades of sandpaper that were markedly different in roughness. These sheets of sandpaper were mounted on wooden blocks and provided the four surfaces that were to be distinguished by the subjects in the experiment. Subjects were required to detect differences in roughness by examining the four surfaces with the tip of his cane. Each surface was designated by a number, and subjects were trained until they could make errorless absolute identifications of the four surfaces. In acquiring this skill, subjects used a cane constructed of aluminum tubing, type 2020-T3?, with an outside diameter of 1/2", and a wall thickness of _____. The cane was fitted with a short wooden tip, 1/2" in diameter, and a round wooden handle 1" in diameter, and about 6" in length. This handle was flattened on one side, so that subjects could orient it in the same way, from trial to trial, without difficulty. With this preparation, subjects were ready to perform the roughness discrimination task, using a variety of different canes.

There are several variables that might reasonably be expected to affect the information handling capacity of the cane; for instance, its length, weight, the distribution of weight or balance, its flexibility, its grip, its tip, its life, etc. Of course, these variables interact with other variables in the cane-user system in determining performance. User variables would include the subject's intelligence, his motivation, his sensory and motor capacity, his perceptual and cognitive ability, the kind and amount of his prior experience in using a cane, his prior experience in negotiating a particular environment, and the particular technique with which he manipulates his cane. Finally, the environment itself would present a host of variables bearing on performance. These variables would include the amount of topographic uncertainty, the subject's estimate of the risk entailed by errors of various kinds, the amount of additional information available from the environment (such as auditory information), etc. Of course, any complete description of the cane-user system will have to take into account all of these variables and more. Furthermore, an assessment of their unique and interactive contributions to total performance, the ability to make reliable

quantitative assessment of total performance in relation to the user's objective — traversing an unseen environment independently, safely, and efficiently-is needed. One of our conference participants, Dr. Leonard, has made significant progress in this regard.

From what has just been said, it is clear that the problem of analysis will be difficult and complex. In order to get some pilot research underway, I chose to concentrate initially on only a few variables related to the cane itself, and to measure a kind of performance that is admittedly much less complex than the performance of the cane user in the real world. If my plans develop, I will be in a position to attempt the assessment of total, real world performance, and to use such performance as a criterion in assessing the effects of the variables to which I have referred. However, the experiment I am reporting today is one, the nature of which has been dictated by my current capability. I am well aware of its shortcomings, but I made the judgment that it would be worthwhile to initiate research in this area, even if I had not yet developed the facilities and resources to accomplish the kind of research that will ultimately be required.

Working within these limitations, the experiment I am describing is designed to explore, in a tentative way, only a few of the factors that might affect the efficiency of a cane, and under an admittedly limited range of circumstances. The three variables represented in the experiment were weight, length, and flexibility. Canes, 40", 50", and 62" were employed in the belief that these values might span the range of cane lengths generally employed. These three canes were alike with respect to weight, flexibility, and the kind of grip and tip. Two canes, one weighing 316 grams, and one weighing 90 grams, were used. The difference in weight was accomplished by using stainless steel tubing for one cane, and aluminum tubing for the other. These canes were alike with respect to length and the kind of grip and tip, and, within practical limits, flexibility as well. To achieve three canes that differed with respect to flexibility, one cane, the least flexible one, was constructed of aluminum tubing. The two remaining canes were constructed from two pieces of plastic tubing that differed considerably from each other and from the aluminum cane in their flexibility. To measure flexibility, the handle of each cane was securely clamped to the horizontal surface of a desk while the remainder of the cane extended beyond the edge of the desk. A 100 gram weight was affixed to the end of each cane, and the downward deflection of the tip of the cane was measured. The downward deflection of the most flexible cane was 16"; the downward deflection of the cane of intermediate

flexibility was 7"; and the downward deflection of the least flexible cane was 1.5". These three canes were alike in length, grip and tip, and they were nearly the same in weight.

Five blinded veterans served as subjects in the experiments. Although all of them placed daily dependence upon the use of the long cane, they varied considerably with respect to their mobility skills. A couple of them had attended the rehabilitation center operated by the Veterans Administration at Hines, and the remaining three had acquired their mobility skills by less formal instruction.

Four sessions were required to test each subject. During the first session, the training trials were administered that were required for the absolute identification of the four roughnesses used in the experiment. In each of the remaining three sessions, the subject was given a few rehearsal trials on absolute identification, in order to bring his skill back to the criterion of errorless performance, and was then required to demonstrate his ability using canes that differed with respect to one of the three variables in the experiment. While subjects were learning to make absolute identifications, they were informed of the correctness of their guesses. However, during the actual tests, they were not given knowledge of results.

Here are the results of the experiment. Proceeding from the most to the least flexible cane, the average amount of information transmitted, in bits, was 1.06, 1.08, and 1.26 bits. The maximum amount of information would have been two bits. Thus, these results suggest that the less flexible a cane is, the more information it will transmit. I am sure that this finding will surprise no one. It seems obvious that a flexible cane would damp out the vibratory stimuli used by subjects in making texture discriminations and other discriminations with a cane. Nevertheless, the experimental demonstration of flexibility provides evidence to support the generally held belief regarding the effect of flexibility.

When weight was the variable, the heaviest cane transmitted 1.1 bits of information. The lightest cane transmitted 1.2 bits of information. As in the case of flexibility, I believe this finding to be consistent with the experiences of cane users. It seems to suggest that the lighter a cane is, the more efficient it is at collecting information.

The results were not as clear when length was the variable. Proceeding from the shortest to the longest cane, the amount of information transmitted was 1.03, 1.14, .97 bits. These results suggest that there may be an optimum cane

length, and that deviations from this length, in either direction, may result in a deterioration in performance. However, the differences associated with cane length were quite small. In any case, the length of an individual's strides is probably a more important factor in determining the length of a cane, since the cane must be long enough to give the user information about critical features of his environment in time for him to use this information. He must have this information before he takes the next step, not during its execution.

The differences just reported were examined for statistical significance. Some of them were large enough to achieve significance. However, others were not, and skepticism regarding those differences that were significant is probably warranted. Nevertheless, I feel that the experiment fulfilled its purpose as a pilot study. Its outcome suggests to me that the variables examined do influence the user's performance, and that they should therefore be given more careful experimental considerations. Further experiments are now being planned in which a larger number of values for each dimension will be represented, and in which data will be collected from a larger number of subjects.

Though I hope that experiments of the sort just described will provide useful information, my real objective is to develop a test environment in which total performance can be evaluated quantitatively. The user, moving through this environment, will encounter problems of the sort he must solve to accomplish independent cane travel in the real world, and provisions will have been made to assess his performance quantitatively as he moves through the environment. This standardized test environment will constitute a meaningful criterion in terms of which to evaluate the efficiency of both canes and the user of canes.

Of course, the emphasis in the present line of research has been on the cane, rather than its user, because it is believed that the cane is an important component of the total system. If one cane can be said to be better than another, its superiority must be describable in terms of one or more of the descriminable dimensions of variations which, taken together, define the complex performance called cane travel. This performance is a product of the interaction of the traveler, his cane or instrument, and his environment. If it can be shown that variations in one or more of the dimensions that define the cane makes a quantitative difference in performance, the kind of information can be selected that will decide the superiority of one cane over another. It should ultimately be possible to state that optimum combination

of cane characteristics that will maximize its efficiency as an instrument for transmitting information from the environment to the user.

So far, I have been talking about canes that have been constructed so as to produce desired values of cane dimensions, such as length or weight, for research purposes. Many of these canes would never be given serious consideration for actual use. However, a secondary objective of my work in this area has been to develop canes for actual use that seem to me to represent improvements, in one way or another, over existing canes. Until the standardized test environment of which I spoke a few moments ago is available, such canes can only be evaluated by the opinions of users, and there are situations in which a user's performance is more to be trusted than his opinion. Nevertheless, I have decided to initiate this part of the project in the hope that measurement of the total performance will soon be possible, and I have decided to rely upon the opinions of users in the meantime.

I have been collecting different materials from which canes might be constructed as, I am sure, many others have also done, and I have constructed canes from these materials that may differ, in some respects, from the canes that are ordinarily used. I have brought a few samples with me and I would like to show them to you now.

This cane is constructed from the shaft of a new golf club that has recently come on the market. The shaft is a high strength aluminum alloy and it is tapered, reducing in diameter from 1/2" near the handle of the cane to 1/4" at its tip. As the diameter of the shaft decreases, its wall thickness increases, so that the shaft is uniformly strong throughout its length. I have used a small hammer handle for the grip on this cane, believing that if a cane is to be used actively as a tool for collecting information from the environment, one must be able to grip it firmly, manipulate it skillfully, and use it assertively in an active search strategy. On the other end of the cane, I have mounted a tip that I obtained from the American Foundation for the Blind. This tip consists of a polished metal coaster mounted on a soft rubber cushion. This tip is mounted at an angle to the shaft of the cane so that its metal coaster is flat on the ground when the cane is held at its usual angle. With the tip mounted in this way, the cane will pass over a variety of surfaces more easily than canes whose tips are mounted in the usual fashion. I have used a cane of this sort myself and I am convinced that it glides over irregular surfaces much more readily than the conventional cane.

I also have a cane that is collapsible, to some extent. It's not nearly as collap[sible] as the canes that are being developed at the Center, but I have reasoned that, in many situati[ons]

what the cane user needs is not a cane that will collapse to a pocket size, but to a size at which it can be handled conveniently while sitting down on a bus, at a restaurant table, or at a seat in the concert hall. The cane I have here was made from an ordinary tripod leg. It has only one telescoping section. However, it will collapse from approximately 50" to approximately 25", a length that can be handled conveniently in situations of the sort just mentioned. It is stronger than telescoping canes with four or more sections, and its length can be adjusted in accordance with individual preference. This cane could, of course, be fitted with any desired kind of tip.

The next cane I have to show is one that has been equipped with a castor. This castor has been carefully machined so that it is quite responsive. A small neoprene tire has been provided to reduce the clatter as it rolls over concrete surfaces. Because both the wheel bearing and the castor frame bearing have been carefully made, it moves over irregular surfaces easily, and the same search strategy can be employed with this cane as with the ordinary cane. That is, it can be moved in an arc from side to side as the traveler advances. Its advantage is that it monitors continuously the surface over which it passes and therefore provides more information to the user. The typical cane, conventionally used, samples surface characteristics only on those brief occasions when it touches the ground. Since the castor cane is always in contact with the ground, it is providing a continuous stream of information about surface characteristics. For instance, with the use of this cane, it is practically impossible to fail to detect a step down. The edges of walk and other shore lines can be followed quite easily. This cane is only the most current instance of developmental efforts. Other models have been made, studied, and discarded. I have learned that bearing surfaces must be machined to close tolerances, that ample clearance must be allowed between the wheel and the castor frame wherever possible, that materials must be chosen for both strength and lightness, and that bearing surfaces must be kept lubricated. When you consider that the castor is mounted at the end of a shaft some four feet from the hand of the user, weight becomes an especially critical factor. This castor is a little too heavy, but I am now arranging for another one to be made that should be significantly lighter. I believe that it will be possible to make a castor light enough so that use of the castor cane will not be fatiguing to an individual. I have used this cane myself, over several weeks, and I am encouraged by my experiences with it. Although this model has problems, I am confident that when they are eliminated, I will prefer the castor cane to the conventional cane. Several years

ago, I was talking to a mobility instructor in a hotel lobby, during a convention. We were discussing the various kinds of canes that might be tried or that had been tried. He was of the opinion that the cane then in use (the standard long cane), was the ultimate technological achievement in this regard. He was relating, somewhat scornfully, the encounters he had had with people who had attempted to construct or use other kinds of canes. One anecdote he related with special relish had to do with a man who he regarded , I gather, as "some sort of a nut." He informed me, with a voice redolent with incredulity, that this demented individual had actually had the gall, the temerity to suggest a cane with a wheel on the end of it. I could tell that my informant was confident of my reaction, so I didn't say anything. However, I privately wondered why the idea seemed so preposterous to him. I had often thought of trying out a wheel, and this thought had not inclined me to the low opinion of myself that my informer held of his "nut." Therefore, in spite of the caution engendered by such a clear and unmistakable warning, I have overcome my reluctance as you can see. Before leaving this topic, I would like to mention one additional observation. As the cane rolls over surfaces with different characteristics, it transmits to the hand of the user distinctive patterns of vibrations. It is a simple matter to distinguish a brick walk from a concrete walk, and either of these from a gravelled surface, and a grassy surface is, of course, also distinctive. Incidentally, I was surprised and pleased to learn that a well made and properly lubricated castor will pass over a grassy surface freely.

This concludes the description of my work in connection with the cane. To summarize, I have performed some very simple experiments, the results of which I hope will assist in selecting a cane which does a more efficient job in selecting information from the environment. However, I recognize that canes and the users of canes cannot be studied with real effectiveness until a standard test environment, with important features of the real world, is available. I am planning to provide such a test environment as time and money permit. Finally, I am constructing and evaluating, in a less formal way, some canes that may represent improvements over existing canes.

TOWARDS THE MEASUREMENT OF PERFORMANCE OF TRAVEL SKILL

J. A. Leonard and R. J. Wycherley*

Abstract

In this paper we describe a first attempt at 'measuring' performance in blind travel. There is little doubt that we need such measures both in the fields of rehabilitation and research. The difficulty arises from two facts; firstly, that so far there are no generally accepted criteria of travel performance, and secondly, that it is in the nature of a skill such as mobility in general and travel specifically that it is difficult to carry out objective measurement.

In Part I we discuss these two problems in some detail and suggest a possible solution. In Part II we describe a study in which we tried to apply the suggested solution by observing the performance of 59 blind youngsters when negotiating unguided, an unfamiliar test route after a single previous guiding.

It is the contention of this paper that we are now moving towards a point in time where we can begin to put forward generally acceptable criteria of performance and that we can try to assess proficiency in attaining these criteria.

Part I

The Need for the Measurement of Travel Performance.

We need measures of travel performance in the two fields of rehabilitation and research. In the former we want to know the effectiveness of training procedures, we want to be able to spot weaknesses of trainees, and increasingly, we would like to be able to make predictions. Predictions about the general suitability for mobility training (Graham and Clarke, ed. 1965), about suitability for different types of training, and about the likely final level attainable by a potential trainee. As far as research is concerned, we want to know what different classes of blind people can already be expected to achieve by existing methods, what kind of devices to go for next, and how to evaluate these devices. Thus in both areas we want to know how effective our solutions are in achieving stated objectives for a given set of people. In both we also want to know what needs to be done about those people who do not reach these objectives and what to do to get beyond presently attainable objectives. Thus, which ever way we turn we find the need for specifying in some detail ultimate and intermediate objectives.

---

* Medical Research Council, Department of Psychology, University of Nottingham, Nottingham, ENGLAND.

Standards.

It is presumably accepted that the ultimate objective in our field is to be able to make the blind as mobile as the sighted, however far off we may be at present in attaining this objective. Our intermediate, sliding standard should clearly be that level of performance which at any point in time can be achieved by an acceptable proportion of blind people by their own efforts or as the result of existing training methods.

The question therefore arises whether there is any meaningful way in which we can provide a more detailed specification of this sliding standard in our time. What is more, can we do this in terms which are reasonably easily communicable and unambiguous?

Specifiable Criteria.

As a result of several years of work in the field of blind mobility, and more particularly during the last two years in close contact with guide dog and long cane orientation trainees, we would now like to suggest that it is possible to lay down some more detailed and perhaps generally acceptable criteria for blind travel. That is to say, we can begin to specify in much more detail just what we can expect of a competent traveller whether self-trained, or trained by one of the two established training methods:

Traveller can

1. Move through familiar environment
2. Move through unfamiliar environment
3. Move at speeds equal to sighted
4. Travel straight line midpavement
5. Detect end of blocks
6. Detect and anticipate downkerbs
7. Cross straight or correct veer
8. Detect and anticipate upkerbs
9. Make indentations
10. Pick up true path
11. Detect obstacles/landmarks auditorily-tactually
12. Sense environment auditorily/tactually
13. Handle effectively sighted help
14. Handle effectively public transport

and we might want to add that he can do these things safely, reliably, and purposefully. Safely in the sense of not endangering himself or others, reliably

in the sense that he can do it repeatedly and under a wide range of conditions, and purposefully in the sense that he has a body of knowledge which can be applied systematically as distinct from haphazardly.

It will be noted that we have not said anything here at all about cane, dog, or orientation techniques as such, but are talking primarily in terms of relatively easily observable operations common to all modes of travel.

It will also not escape the reader that in arriving at this first checklist we have borrowed freely from literature; from Wright's Mobility Competency Scale, Wurzburger (in Clarke, ed, 1965),Leonard (1966), and Menzel, Shapira, and Dreifuss (1967). All these contain attempts at varying levels of complexity and details of assessing travelling skill. The list which we present here takes what might be considered as key items.

Looking at our list one might well ask, in what sense does the blind traveller not measure up to the fully sighted performance? For the items in this list would appear to describe a level of performance already pretty close to, if not identical with, that of the sighted. The brief answer must be that extensions now lie in the direction of making it far easier for larger numbers of blind people to achieve these kinds of levels with much less stress. The number of blind travellers capable of performing at these levels in a wide range of familiar and unfamiliar environments is probably small when compared with the total population at risk, and the majority of those reaching these levels even in a limited number of situations will have been enabled to do so as a result of extensive training. Compared with sighted travel, it is reasonable to assume that almost all blind travellers will move about with greater effort and under greater stress.

Utilization of Criteria.

Let us assume for the moment that this checklist which we have produced, this collection of criteria,does in fact represent a consensus about what constitutes top-level mobility at present. How can we tell whether any particular blind person meets these criteria or the extent to which he falls short of them? This brings us to the second of our difficulties mentioned in the very first paragraph, that of measurement.

This in turn, has to be broken down into the problem of how to 'measure' performance on each item (data collection), and into the problem of how to combine the scores obtained from each item (data handling). Of the items listed, only No. 3, speed of travel, can be measured truly objectively. Items 4-11 can

just about be answered in a yes-no fashion, while the remainder are more difficult to deal with, though even here we are beginning to have quite specific points which we would look for and for which we could build up further 'measures' from survey data (Gray and Todd, 1967).

Data Collection.

But how do we actually obtain the scores? We can either ask our blind traveller and accept his word for it. We are beginning to do this here when blind people ask us whether we think they might benefit from a form of mobility training. Or we can ask a blind person's teacher or instructor to provide the answers - we are beginning to do this when we discuss levels of mobility attained in various schools. And finally we can take out our blind person and observe them ourselves in the street. Here we can either do it individually in a spot check manner, or else we can go to more trouble and arrange for groups of blind people to be observed while travelling, by themselves, and one at a time, over a specific test route. This is in fact, what we have started to do and it is the result of one such exercise which we wish to report. Here is the rationale underlying this approach; any given route from A to B can be regarded in terms of a succession of street blocks. Within each block the traveller has to carry out in sequence more or less the same set of operations or sub-tasks (this is the equivalent to breaking down an industrial skill into successive cycles of operations, with each cycle being composed of a sequence of identifiable operations). Starting the cycle at the moment when the subject has stepped into the side street to be crossed, we observe whether he corrects for it or not. We note whether he detects the upkerb or stumbles onto it, whether on gaining the upkerb he picks up his true path or fumbles about, whether he travels straight or in a zig-zag line, whether he keeps clear of walls and kerbs or hugs either of these, whether he avoids obstacles along the route and makes use of landmarks, whether or not he detects the end of the block, whether he anticipates the down-kerb or falls off it, whether he squares up and listens before stepping off. We can also measure the time required to deal with each block, and whether he makes any errors of navigation.

Data Handling.

From observations of this kind we can proceed to deal with the data in increasingly sophisticated ways. The simplest and first step is to fill in the check-list appropriately, immediately after having taken our traveller

over this test route; e.g., we could say that in general he had kept to mid-pavement, had not fallen off downkerbs, had crossed without veering and so on.

We could improve on this if we could base this overall type of assessment on recorded observations during the journey (this is in fact as far as we have been able to go in our study). And, finally, we could so arrange matters that we would record performance on each item for each cycle (street block). We could them summarise the data for each traveller in the following way; for a route comprising 10 blocks he kept to midpavement on 8 blocks, had not fallen off any downkerbs, and had made 7 crossings without veering and three with veering corrected, etc., etc.

So far, then, by either method, we would finish up with a completed check-list for our traveller and we could use this to give us a 'profile' of his performance level. If the checks are all in the 'yes' column of that list, we might then say that he was good and if all in the 'no' column, we would say that he was bad. In most cases, however, there will be some 'yes' and some 'no' responses. We could certainly use such a profile to spot certain weaknesses on which to concentrate in further training, but it would be difficult to use the raw data in order to compare or categorise individual travellers. We can, however, combine profiles of several travellers, say from one age group, and compare two groups - as will be seen in our results section. From this sort of combination of data, we can build up a composite picture of the performance of groups of travellers and we can show the extent to which they differ; one group might show up as having a lot of veering while another group might be poor in maintaining straight lines.

Ideally, of course, one would like to combine the item scores, including the time, to give one some sort of single numerical score, and to produce a more sensitive measure of skill. But this involves assumptions about the extent to which all or any of the items listed are of equal importance and one may require a good deal more work before one can take this next step. For the time being, it may be more profitable to stick to the profile approach and use it to isolate a small number of key items which can subsequently be used to discriminate good from bad travellers.

Sub-Tasks and Sub-Skills.

Given that this type of performance measure is considered to be meaningful, we are even now in a much better position than before to correlate performance on the sub-tasks listed above with a number of sub-skill measurements. It is possible to produce a list of items which would intuitively appear to be highly relevant to the total skill of mobility and which could be presented in the form of

a test battery to prospective trainees (for selection) for those under training (as a diagnostic tool for selected aspects of remedial training) and for those who have already achieved competence (as a means of validating the various types of measures). Such a battery might be made up based on the work of authors listed in brackets: e.g., orientation in geographical space (Worchel, 1951), straight line walking, detection of slopes and curvatures (Cratty, 1965), echolocation (Kohler, 1964), balancing (Leonard, 1967), posture and gait (Miller, 1967), auditory localization (Fisher), as well as some less easily identifiable personality characteristics (Riley, 1967). Traditionally one would attempt to validate results from such tests against subjective judgements made by competent observers, i.e., teachers or instructors would rate their students and trainees on competence in 'mobility'. Provided one can observe certain precautions, this is a perfectly acceptable procedure - what is more, it is often a simple and economical way of validating tests. At the same time, there are serious difficulties with this procedure and, where possible, one prefers validating tests by more objective measures.

Given, then, that one has measures of performance in the sub-tasks listed earlier, it would clearly be desirable to know the extent to which they were related to performance on the sub-skills, e.g., do people who perform well on Kohler's echolocation tests also detect obstacles efficiently in real life; or do people who show little veering tendency in Cratty's test show little veering tendency when crossing a street? Once we can show which of the tests are really as well as intuitively relevant, we could clearly be in a much better position to use the tests as predictors and indicators of performance; for one function of any form of test is that it enables one to make predictive or remedial statements more economically than observing actual performance.

Summary.

To sum up this discussion, let us go through the key points of the argument. We want to be able to measure skill levels in blind travel. Whether we do this on the basis of subjective judgements or objective measurement, we must first of all have agreed standards and criteria. Having specified our criteria in the form of an itemized check list, we must have some basis on which to score the items. Having established such a basis, we must be able to handle the data obtained, so that we can use them for the purposes for which they are intended. We think that we have reached the stage in which data can be presented in the form of profiles for individuals or for groups. While this does not as yet allow us to grade individuals, it does enable us to compare groups of individuals. The second part of this paper describes a

first attempt at doing this.

If there is agreement on the list of specifiable criteria presented in this paper, we can already discuss travel skill levels attained by individual blind persons to advise on further training, we can compare the output from different training establishments, and we can evaluate the usefulness of new devices. If we can take the next step and establish correlations between sub-tasks and sub-skills, we may be able to use the latter for purposes of selection, diagnosis, and remedial training.

Part II

The Shrewsbury Study

Introduction

This study was carried out in the Copthorne area of Shrewsbury, Shropshire, England, from 17th-21st July, 1967.

The students observed were members of the Royal Normal College. They had been given mobility training for different periods prior to the exercise, and by different instructors, but all used the short cane. At RNC, as at other schools in the U.K. where mobility is taught, there are very considerable difficulties with regard to staff/student ratio and curriculum time for mobility instruction. We, on the other hand, were able to assign one experimenter to each student to do first the guiding over an unfamiliar route and then the observing. The students were totally unfamiliar with us as experimenters and we clearly asked quite a lot of them; they had to trust us to guide them safely over a new route and to look after them while they walked around unguided. They had to walk along an unfamiliar route and on top of this, they knew that they were being observed. Yet they all cooperated most cheerfully and wholeheartedly and for this, we would like to express out appreciation.

Method

Subjects.

The subjects in this study were 59 students aged 15-21 years, 30 boys and 29 girls. As far as vision was concerned, only two had more than 'perception of hand movements.'

Experimenters

Five experimenters were available of whom all but two had had at least 18 month's experience in the field. The other two did not start acting as observers until the second day of the work.

Route

A route was chosen in a quiet residential area of Shrewsbury (Fig. 1). It was about 1/2 mile long and had little pedestrian or vehicular traffic for most of the time. Each student was first guided individually over the route by an experimenter who pointed out peculiarities and relevant landmarks for the crossing of streets. At the end of the route, student and experimenter were picked up by car and returned to the starting point. The student was allowed to rehearse the route verbally before setting out unguided, followed by the experimenter.

Scoring

The route was broken down into 7 sections (Fig. 1). Within each of these sections, the experimenter tried to score his subject's performance on a number of criteria in a more or less yes-no fashion (score sheet for details in appendix). The experimenter also noted the stopwatch time at the end of each section.

When the subject had completed the route, the experimenter filled in an Assessment Form (see same for details in appendix). On this the overall performance of the subject was assessed by the same criteria as had been used for each section. The experimenter then classified each subject under two headings: I) A. Completed route without help, B. Did, but required some encouragement (e.g., subject: "I should cross here, shouldn't I?" Experimenter: "Yes."), C. Required help to complete route (e.g., Experimenter: "Come back, you have gone too far."); and II) Is subject suitable for training in the use of maps? Note that "I" is a 'hard' score, based on the record while "II" is a 'soft' score based on the record plus the experimenter's judgement.

Note also that the bulk of the statements on the Assessment Form represent general characteristics of performance, e.g., when we say 'travels straight', this means that on most occasions, the subject maintained a straight line on the pavement.

The data from each individual Assessment Form were then transferred to summary sheets for the four groups of subjects: Senior Girls, Junior Girls, Senior Boys, Junior Boys. Similarly, the times to reach the end of each section

were transferred to summary sheets. These data were then added up for each group and for all the students, and percentage scores were obtained under each heading. Our factual statements are, therefore, based on those data derived from the summarized Assessment Forms, as far as criteria of mobility are concerned.

Administration

Students had to be collected by car from the College and were taken to a car park near the start of the route. Here the school bus acted as a mobile office-cum-waiting room where students were checked in, assigned to experimenters, and where one member of the team kept records up to date. Experimenters took turns in operating the shuttle service between finish and start of the route. One further member of the team drove the car which brought students to the site. Members of the College's staff ensured that students were available at the appropriate times. Typically, we would collect one group of three to four students and start them off at intervals. While this group of students carried out their test, the next lot of students would be collected. When the first group had finished, they were taken back to the College and the next group collected. Thus at least one member of the team of experimenters was free during any given 'cycle' of operations. We aimed at having to test two groups each morning and each afternoon. For this particular length of route and this particular task it turned out that there was hardly any down time.

Results

i) For the present purpose, we propose to present only scores for the group as a whole, and for the four sub-groups separately. Except in the case of time, we have not made any attempt to rank the subjects though we may do so later.

ii) Table I shows the results obtained on 16 items for the group as a whole in column a and for the four sub-groups in columns b-e. The entries for the first 14 items are in the form of percentages of students who fulfilled a given criterion, the 15th item is mean time to complete the route, and the 16th item is the mean time rank. The first 12 items describe in a more or less meaningful sequence, performance on items making up the repetitive cycle of events when negotiating a street block. Note that hardly

any of the students travelled midpavement (they followed the wall side using a touch technique). For the rest of the items, they were dealt with effectively by 70% or better of all the students except for the veering, item 10. Half of our students, and girls rather more than boys, tended to veer when crossing.

Turning now to item 13, it will be seen that only 15% completed the route without any help, with the senior boys doing rather better than any other group. It is of some interest here to point out that 20% failed because they had to have a veer corrected. This should be taken into account when considering the results on item 10 above.

On item 14 it will be seen that we thought about half the subjects might benefit from training with maps at present. Here again the senior boys did better. A subject would be considered suitable for map training if he was good on basic mobility and showed signs of being able to handle landmarks effectively. Mere failure to complete our route unaided, did, therefore, not necessarily exclude a subject from being judged suitable for map training.

On item 15, the time taken to complete the route; about 20 minutes for the half mile for the group as a whole with boys doing much better than the girls. When we ranked all the subjects for time and took the average of rank scores for each group, we obtained the entries in our last row. This shows in effect that boys had consistently lower scores than girls, though we have not yet carried out a statistical test on this. Since the horizontal axis has been divided to make the distance between successive points proportional to the distances of the appropriate sections, the fairly straight lines obtained suggest that subjects progressed at a steady rate along the route. This figure again supports the case for saying that girls were in general slower than boys, and that they were so all along the route.

iii) We were not able to score errors of route memory very effectively in this setting. This constitutes the biggest weakness in this study. It arose partly from the fact that we were not able to distinguish those turning corners because they had forgotten to cross, from those who failed to realise that they had turned a corner. We have reasons to believe that many of these errors were in fact due to the second of these causes and we would like to draw the College's attention to this again subsequently.

We also noted that many subjects did not make proper use of landmarks or did not get themselves into a position which ensured that they would encounter landmarks, e.g., they might remember that they had to cross by a tree standing

close to the kerb, but did not go to the kerb in order to find it. But this again we were not able to score reliably.

Finally, we were not able to score the steadiness of progress. Some subjects might walk all the time at a steady, smooth rate with little or no slowing down or stopping. But the majority proceed rather more intermittently, stopping to extract a cane from a crack or fence or hesitating at an open gate perhaps. This aspect of a performance is almost always very difficult to score unless one goes to great length of instrumentation.

There were, therefore, at least three things we failed to score and, of these, one should be able to score two on a future occasion.

Discussion

The General Picture

It seems helpful to attempt to give a picture of a sort of typical RNC student as it emerged from our data and comments. It should be noted that there will, of course, be some who are very much better and some who are rather worse.

The hypothetical, average, RNC students walk at something like 1 1/2 m.p.h., progress being a bit intermittent rather than completely smooth. In general, travel is along a straight line as distinct from an intermittent rebounding off walls, let alone a continuous alternation between bumping into walls and falling off kerbs. In general, the student will have little idea of how to gauge the width of the pavement, but coming off the pavement accidentally is a very rare event indeed. Any obstacles such as telegraph posts or trees along the wall are dealt with well, they are detected in time to prevent collision and detoured without difficulty, but a break in the wall can cause some difficulty.

The short cane will maintain contact with the wall most of the time, but chances are about even that our average student will use the cane systematically as forward protection in alternation with prodding the wall. The student will keep pretty close to the wall and will, in general, be seen to follow its contours pretty closely. This tends to result in a not uncommon tendency to follow the wall round the bend at the end of street blocks without the student realizing it. Landmarks for crossing are remembered, but there is a good chance that the student will not get himself in the correct position for ensuring contact with the landmark. And, there is also a good chance that not all the features of a landmark are made use of so that a crossing may be attempted

in the wrong place.

When the downkerb is reached, the student will get to the kerb without falling off, square up and listen before crossing. With good surface underneath, there is only little chance of veering, but when the surface is rough, a straight crossing is less likely. The chances are about even that such a veer is self corrected. The upkerb is gained without stumbling and the straight line picked up well on the other side.

Thus the picture as a whole is one of quite purposeful activity along pavements and in crossing streets, and a lack of ability in dealing with the problems of orientation.

Sex Differences

The most obvious difference between the groups was between boys and girls, and more particularly between Senior boys and the rest. The Senior boys were the fastest, had more potential map users, had more completers than the rest, and tended to have the least number of veerers. In all but the speed item, their superiority could be due to a difference in, and/or a greater length of training. But in speed, the Junior boys were effectively their equal. It is true that we had relatively few Junior boys and girls and it may be that we did not get a complete picture from the Juniors. But it may also be possible, and not unreasonable, that boys will have a tendency to be faster, given a chance.

Veering

A more detailed analysis, not yet complete, suggests that veering occurred mainly at those two crossings where the road surface was poor. It also suggests that a good bit of the veering observed was not serious under the conditions of the exercise, i.e., it did not actually bring subjects into danger. But there is also evidence that not many subjects knew how to correct for veer.

Wall-Following

Although we failed to score the incidence of subjects going round a bend without apparently realizing that they had done so, we observed enough of it to draw attention to it. This was, of course, to some extent a direct function of using the short cane and maintaining wall contact with it, but one suspects that it was also due to the relatively slow rate of progress. The slower a person moves, the less he is likely to note any changes signalled by his senses whether this be sound, touch, joint senses or smell - within certain limits this is a basic fact of sensory physiology. A student walking quickly along a wall and

taking a bend is more likely to note a change of direction either through his body as a whole or through his ears by way of echoes and street sounds - he is, of course, also in greater danger from the consequences of a collision, and safeguards against this have to be weighed against increased speed.

Failure to Use Landmarks

Another not scored item. We were under the clear impression that subjects knew the function of landmarks but that the majority of them had little idea of how to make the best use of them. This again is possibly partly due to a lack of awareness of the nature of the environment, of the concept of streets, of the notion that a pavement has an ascertainable width, and of the possibility of exploring and utilizing arms plus cane. There was one admittedly difficult but very interesting landmark which required memorizing three features; at the end of an iron railing there was a thick hedge, and this point was some 15 feet or so after one had made a turn and gone downhill. It so happened that there were one or two other places where the fence merged into a hedge, but along a straight bit of pavement. And this, not unnaturally, led to some confusion. This kind of thing suggests useful exercises where one would set up such configurations deliberately.

On this point of landmarks, it is worth noting that with really highly mobile subjects, we would not use specific landmarks at all to denote crossing points. We did it here because earlier observation of some of the students had suggested a need for it. Ideally one wants to be able to say no more than first downkerb left, second upkerb right, etc. and leave the tactics of crossing to the blind person.

Comments

On the basis of our observations we were then able to make certain recommendations to the Principal and teachers at Royal Normal. These related to pavement positioning, speed of walking, use of echoes and street sounds, veering and veering correction, general environment sensing, use of landmarks and end of block detection. These recommendations have since been discussed and, where possible, suitable action has already been taken.

As far as we ourselves were concerned, there were clearly points of technique and methodology which should be dealt with in the future. We would want to extend our present scoring method by keeping the basic scoring form, but doing the actual recording on a tape recorder. This would ensure on the

one hand that we would put down items in their proper sequence while on the other hand enabling us to make more frequent and more detailed observations. One would want to include items concerning 'false turns' and 'use of landmarks.' One would certainly want to make observations systematically in each block so that one could have a more quantifiable item score. Ideally, too, one would like to have more than one observer per student.

Granted then, that this was by no means a perfect job, we would submit that this represents a more objective manner of assessing travel skill than any reported so far. It is not exactly cheap all round in terms of manpower and time required. But, by having all students cover the same unfamiliar route under the same conditions, by combining our scorable items, our judgements, and our general observations, we were able to present this particular college with a reasonably accurate account of the effectiveness of their current training methods. Provided that one can find comparable routes in other localities, one has here a potential tool for comparing different schools; comparable in terms of length of route, traffic level, nature of pavements, number and type of crossings, etc. In most towns in the United Kingdom, it should be possible to find something closely similar in a quiet residential area.

This, then, is as far as we have got in this attempt at measuring travel skill. Before we refine the method in a future exercise, we hope to be able to complete work on the measurement of 'stress' during travel. This should then provide us with an additional objective measure. And, we then hope to be in a position to compare different types of travel aids under different travel conditions, combining criterion observation, measured time, and a measure of stress.

Acknowledgements

We are glad to acknowledge the help and cooperation received from the Principal, Vice-Principal, staff and students of the Royal Normal College. Dr. J. Armstrong, Miss Hilary Cope, Mr. R. C. Newman, Miss M. Nott, and Miss J. Pare were members of the team. The work was financed by the Medical Research Council.

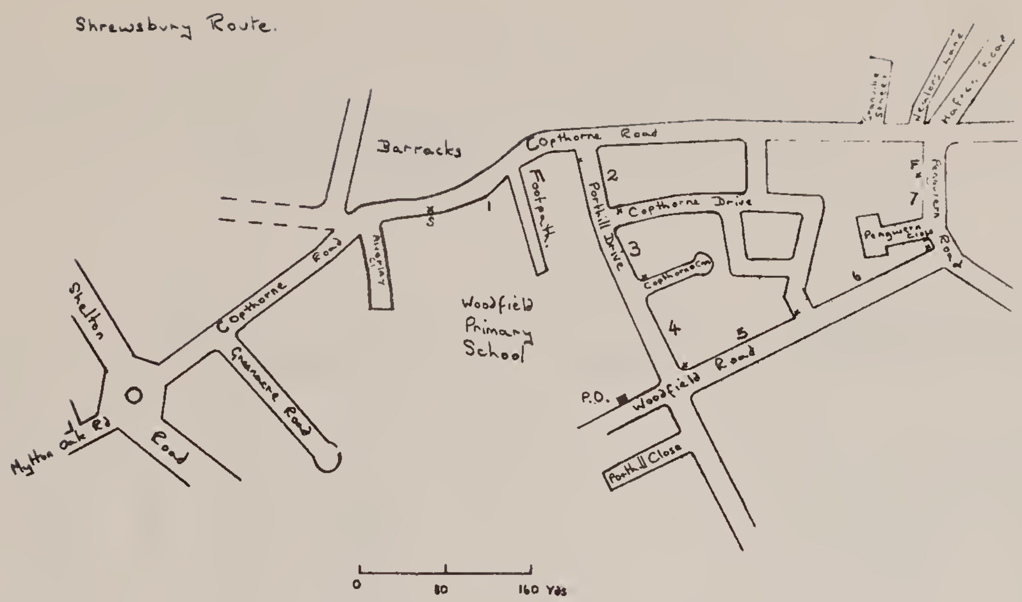

Figure 1

The Route with Sections Shown
S = Start
F = Finish

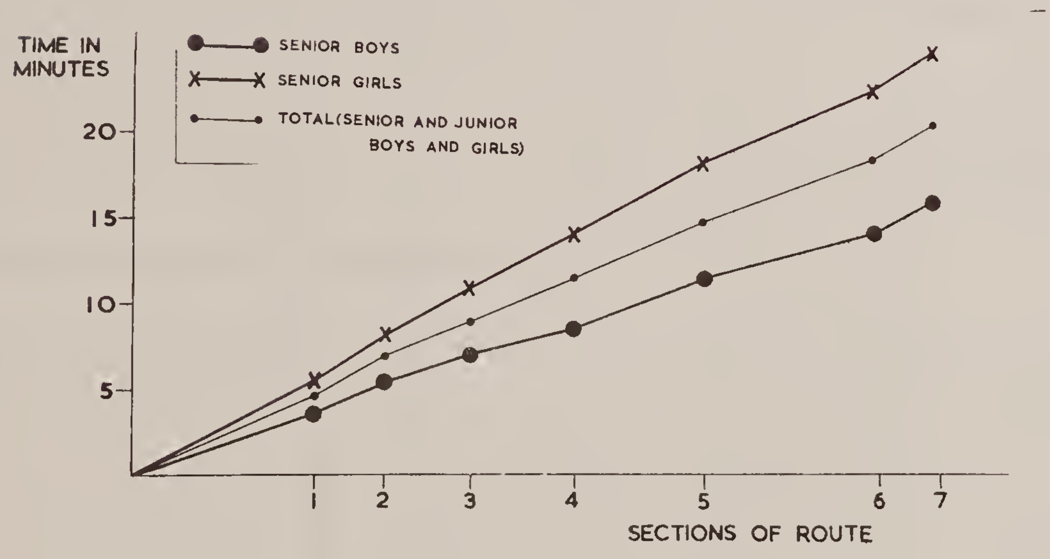

Figure 2

Shrewsbury Study
Cummulative times for Route by Sections: Senior Boys and Senior Girls (Juniors were very similar to Seniors).

Table 1: Summary of Results

				a	b	c	d	e	
				T	SG	JG	SB	JB	
		Number of Subjects		(59)	(22)	(7)	(20)	(10)	
1	(1)	Mid Pavement Position	:	7	0	14	5	20	%
2	(14)	Travel Straight	:	98	95	100	100	100	%
3	(15)	Do Not Bump Walls	:	85	86	100	75	90	%
4	(16)	Do Not Fall Off Kerbs	:	100	100	100	100	100	%
5	(13)	Detour Obstacles	:	81	86	100	70	80	%
6	(9)	Make Indentation	:	97	95	86	100	100	%
7	(2)	Anticipate Downkerb	:	92	90	86	95	90	%
8	(3)	Square Up	:	88	90	86	90	80	%
9	(4)	Listen	:	95	100	71	100	90	%
10	(5)	Cross Straight	:	59	55	29	80	50	%
11	(7)	Anticipate Upkerb	:	97	95	100	100	90	%
12	(8)	Correct Upkerb Drill	:	88	90	86	95	70	%
13	(17)	Complete Route Unaided	:	15	0	14	35	10	%
14	(18)	Could Use Maps	:	49	32	29	80	40	%
15	(19)	Complete Route In	:	20.3	24.6	23.9	15.7	17.3	Mins.
16		Average Time Ranks	:		41.5	42.1	17.0	22.0	

Observer.......................... Subject's Name....................

Initials....................

Shrewsbury Study, July 17th-21st, 1967.

Score Sheet A

Degree of Vision L R
Onset
Other Impairment

Form..............Date.....Start....hrs.

Birth Date...............Finish.....hrs.

	5/6 crossing	7 up kerb	indent.cor.	correct path	8 position	14 bump wall 15 16 off kerb	11 obstacles 12	13 detour	indentation	2 down kerb	arrival time	3 squares up	error mobility	listen	
1) School Path Porthill					M W K	S W K	A T B	Y N	Y N	A C F		Y N		Y N	
2) Porthill Copthorne Dr.	S V C	A C F	Y N	S	M W K	S W K	A T B	Y N	Y N	A C F		Y N		Y N	
3) Copthorne Dr. Copthorne Cres.	S V C	A C F	Y N	C	M W K	S W K	A T B	Y N	Y N	A C F		Y N		Y N	
4) Copthorne Cres. Woodfield Rd.	S V C	A C F	Y N	C	M W K	S W K	A T B	Y N						Y N	
5) Woodfield Rd. Copthorne Dr.				L	M W K	S W K	A T B	Y N	Y N	A C F		Y N		Y N	
6) Copthorne Dr. Pengwern Rd.	S V C	A C F	Y N	C	M W K	S W K	A T B	Y N						Y N	
7) Pengwern Rd. Pengwern Cl.				L	M W K	S W K	A T B	Y N	Y N	A C F		Y N		Y N	
8) Pengwern Cl. Terminus	S V C	A C F	Y N	C	M W K	S W K	A T B	Y N						Y N	

SUBJECT'S NAME.............................

SHREWSBURY STUDY, JULY 17th - 21st, 1967.

ASSESSMENT FORM

(B)

1	PAVEMENT POSITION	: MID ( )		WALL ( )	KERB ( )
2	DOWNKERB DETECTED	: ANTICIP.( )	CANE( )	FALLS ( )	
3	SQUARE ON KERB	: YES ( )		NO ( )	
4	LISTENS BEFORE CROSSING	: YES ( )		NO ( )	
5	CROSSES	: STRAIGHT( )		VEERS ( )	
6	CORRECTS VEER	: YES ( )		NO ( )	
7	UPKERB DETECTED	: ANTICIP.( )	CANE( )	FALLS ( )	
8	UPKERB DRILL	: YES ( )		NO ( )	
9	INDENTATION	: YES ( )		NO ( )	
10	INDENT CORRECTION	: YES ( )		NO ( )	
	OBSTACLES DETECTED				
11	AUDIT	: YES ( )		NO ( )	
12	TACT	: YES ( )		NO ( )	
13	OBSTACLES DETOURED	: YES ( )		NO ( )	
14	TRAVELS STRAIGHT	: YES ( )		NO ( )	
15	BUMPS WALLS	: YES ( )		NO ( )	
16	FALLS OFF KERBS	: YES ( )		NO ( )	

GENERAL COMMENT:..

....

....

REFERENCES

Cratty, Bryant J.	1965	Perceptual Thresholds of Non-Visual Locomotion. Part I. Department of Physical Education, University of California, Los Angeles, California, U.S.A.
Fisher, G. H.	1964	Spatial localization by the blind. Amer. J. Psychol. 77, 2-14.
Gray, P. & Todd, J.	1967	A survey of the mobility and reading habits of the registered blind in England and Wales. New Beacon, 51, 176-180, 198-202.
Kohler, I.	1964	Orientation by aural cues, Res. Bull. 4, 14-69.
Leonard, J. A.	1966	Towards a unified approach to the mobility of blind people. Southern Regional Review, 40, 1-14.
Leonard, J. A.	1967	Static and mobile balancing performance of blind grammar school children. New Outlook, in press.
Menzel, R., Shapira, G. & Dreifuss, E.	1967	A proposed test for mobility training readiness. New Outlook, February, 33-40.
Miller, J.	1967	Vision, a component on locomotion. Physiotherapy, 53, 326-332.
Milton, G.	1965	Wanted: a readiness test for mobility training. in Proc. Rotterdam Mobility Research Conf.,133-161.
Riley, L. H.	1966	Evaluation of the sonic mobility aid. in Sensory Devices for the Blind, 153-198. St. Dunstan's, London.
Worchel, P.	1951	Space Perception and Orientation in the blind. Psychol. Monogr. No. 332.
Wright, H. N.	1961	Mobility competency scales. Use of Auditory Cues by the Blind for Travel, J.O. Harris, editor. C.W. Shilling Auditory Research Center.
Wurzburger, B.	1965	Form for evaluating mobility training and performance. in Proc. Rotterdam Mobility Research Conf. 281-290.

LASERS AS MOBILITY AIDS

George Dalrymple*

Why should one consider lasers as mobility aids? Most of the lasers are not suitable as they are too big, too powerful, or too inefficient. There is a class of lasers that is promising. In fact, the speaker following will describe a mobility aid using these lasers. In my short time with the Sensory Aids Center, I have not had the opportunity to observe this device or see any documentation on its latest form. The remarks that follow have to be considered in this context.

The class of lasers that are considered suitable are Gallium Arsenide Injection Lasers. These devices, when operated at room temperature, produce a "coherent" radiation at 0.9 microns in the near IR. Since this wavelength is very close to the visible wavelengths 0.4 to 0.7 microns, the reflection characteristics of most materials are very nearly the same as for the visible. If a suitable signal detection and signal processing system is devised, the information obtained by a GaAs laser excited sensor would be nearly identical to that obtained visually.

The GaAs lasers are typically very small. Those designed for operation at room temperature are approximately 4x4x10 mills, that is 0.1 x 0.1 x 2.5 mm. The required current to drive the laser is on the order of 40 - 100 amps to exceed the temperature dependent lasing threshold. The current pulse must be short since internal temperature rises during a pulse. Typical values are 20-50 nano seconds. If the pulse is longer, the device ceases to be a laser and radiates incoherently. The dynamic impedance is approximately 30 millohm, hence the total voltage required across the laser is a few volts.

Typical peak power outputs for GaAs lasers are 5 to 10 watts. With a pulse-repetition frequency of 500 cycles and a pulse width of 25 ns, the average power is about 60-120 microwatts. Unless the laser is focused up on the retina, this value is probably well below the safe level for eye damage which at one time was thought to be one watt/cm^2.

Laser transmitters have been built in various sizes. The smallest that I have knowledge of is a cylinder 7/8" diameter and 3/8" high. This transmitter did not include a power supply or any optics. This transmitter requires about

---

* Electrical Engineer, Sensory Aids Evaluation and Development Center, 292 Main Street, Cambridge, Massachusetts.

200 milliwatts of prime power.

The output of a GaAs laser is confined to a narrow spectral region, 10 to 30 Å, centered at approximately 9000 Å.(At liquid nitrogen temperatures, $77^{o}K$, the wavelength is typically 8490 Å.) This narrow spectral width allows use of narrow band optical interference filters to reduce or alleviate the effect of background radiation on range performance.

A GaAs laser natural beamwidth varies according to the laser coherence from about 10 milliradians to 200 mr. This beam can be modified in both extent and divergence by appropriate optics.

The small Laser "radar" has been postulated for sensitivity calculation. These calculations were made to serve as a bench mark for future changes in the various parameters and to insure that adequate sensitivity exists within the present state of the art for these devices. Some of the more significant parameters selected were a one inch receiver aperture, a 50 milliradian (2.9^{o}) beamwidth, and an exceedingly poor target reflectance of 1%. The maximum ranges calculated for this radar were 45 meters with an extended target such as a wall and 15 meters for a 6" diameter target. In each case, the limit was due to background radiation. This calculation indicates that sufficient sensitivity exists for this radar to perform the function of a mobility aid.

Several years ago, a very simple laser radar was assembled as a learning tool leading hopefully towards a long range GaAs radar. Its transmitted power density in watts/steradians was approximately 10 times that postulated in the previous section while the other parameters, which enter into the extended target range equation as the 4th root, also differed in total by a factor of 10. This breadboard radar had approximately 6 times the range capabilities of the postulated radar. Summary information on its performance indicates very strong signals under daylight conditions from a brick wall at 50 feet. Quantitative data was not taken as much longer ranges were of interest to that program.

I have briefly investigated several methods of signal processing to be used in conjunction with a laser as a mobility aid. The first method is the striaghtforward pulse radar approach. That is, the transmitter emits a pulse of IR radiation and a receiver looks for energy scattered by the target. The transmitter and receiver beams are aligned such that they have a maximum common volume and parallel axes. The presence of the return signal indicates the presence of a target and the time of the return signal indicates the range

of the target. This can best be shown in a block diagram. (See Figure 1.)

The pulse-repetition-frequency is generated by the trigger generator. Its output, the triggers, are pulses needed to initiate the timing functions of the radar. The transmitter produces a pulse of IR energy approximately 25 ns long when triggered. A pulse this length corresponds to a radar range of 12.1 feet (3.7 meters). This pulse length, 25 ns, is a reasonable compromise over what can be produced by a GaAs injection laser and what is desired. A shorter pulse will improve the resolution but at the expense of system bandwidth. Much longer pulses will last the entire interval of interest and are beyond the capability of GaAs lasers.

The returned signal is detected by a photo diode. The detector for this pulsed radar approach must have sufficient bandwidth, 30 MHz or greater, to pass the pulse with little or no degradation if any measurements are to be made.

The signal is then time gated. The gate passes signals during the time period that a return signal is expected from the range of interest. The threshold circuit then examines the output of the gate and determines if a signal is present. If a signal is present, then the display indicates this fact. This technique does not measure the range but instead tells if there is a target in the range of interest.

If the gate and the threshold circuit matched in length to the pulse, then the maximum response occurs when the gate and return signal are time coincident. Any mismatch in time between the signal and gate, for a constant amplitude, is manifest in a smaller signal, or no signal if the signal falls outside the gate.

In practice, the returned pulse amplitude is not constant from pulse to pulse. Target size, target shape, target orientation, target motion, target reflectivity and range to the target are among the factors that determine the amplitude and shape of the received signal. Therefore, the amplitude of the pulse cannot be used as a measure of range.

The addition of more gates and thresholds are necessary if response from more than one range interval is necessary. Some form of simple logic is required to determine on a pulse basis which range gate has the largest signal and therefore is the range to the target.

If such a system is so simple, why hasn't it been implemented? One of the chief technical problems is the velocity of light and short ranges used in this device. For a 25 ns pulse and a target 10 feet away, the received pulse starts before the end of the transmitter pulse. This places severe shielding and grounding requirements on the device.

To make any accurate time (range) measurements, the pulse distortion must be controlled. This requires large bandwidths, 30 to 40 MHz. Circuits with large bandwidths are low impedance and must dissipate more power than narrow band circuits. Such circuits in the past have been large, bulky, and costly. Present state of the art permits smaller and lower power units. This approach may be feasible in the next few years with the latest developments in integrated circuits.

A method that largely removes the difficulty of time measurement is that of triangulation. The basic technique for this application was first described by Lawrence Cranberg of the Signal Corps in 1945. The transmitter and receiver optics are displaced by a distance which forms the base line of the triangulation system. The boresite axis of the system is the transmitter beam axis. We also assume that the receiver beam axis is parallel to the boresite axis and displaced from it by the baseline distance. A receiver beam is used for each range interval desired. Each receiving beam is aimed such that it crosses the transmitter beam at the appropriate point. A separate detector is used for each beam and is located off the axis of the receiving lens the correct amount to provide the necessary angular offset for its particular range interval.

The triangulation technique relaxes much of the bandwidth requirement, as only the decision has to be made if a signal is present, not the time of the signal. Gating may still be desirable to reduce the effect of background radiation.

In conclusion, I would like to recapitulate. First, adequate sensitivity exists with GaAs lasers and a one-inch diameter receiving aperature to perform the function of a mobility aid.

Second, brute force radar range measurements are difficult to perform since the energy travels with the speed of light and the total ranges of interest are so short.

Third, clever techniques can permit one to determine range without the large bandwidths necessary with time measurement.

Further, since I am so new to this business, it is difficult for me to select the optimum method of communicating the information obtained by a mobility aid, or for that matter how much and what information is desired and is necessary. I would appreciate hearing your ideas on what information is necessary and how best to communicate it.

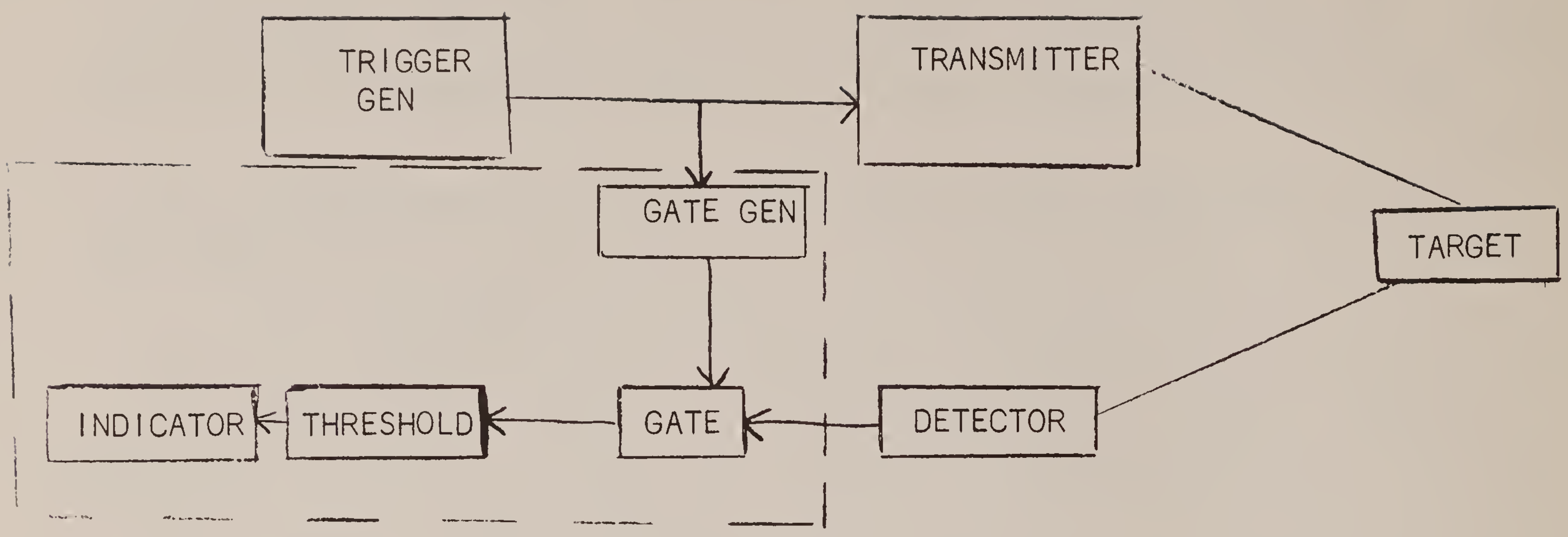
TRIGGER
GEN
TRANSMITTER
GATE GEN
TARGET
INDICATOR
THRESHOLD
GATE
DETECTOR

Figure 1

THE LASER AND THE LONG CANE

J. Malvern Benjamin, Jr.*

I want to start by thanking George Dalrymple, who helped in laying out the background.

Tom Benham of Haverford College, Don Meeks, Ridgely Bolgiano and I have been working at Bionic Instruments for quite a few years now, with support from the Veterans Administration, toward the development of some kind of useful mobility aid for the blind. Most recently it has taken the form of a series of lasers built into a cane.

As Mr. Dalrymple has outlined, this sort of device has advantages compared with other ways of doing the same job. The ranging is done by optical triangulation rather than a time of flight measurement. The trouble with the time of flight approach at present is that the electronics are much too cumbersome. It will take at least two or three years more before that approach becomes practicable.

The device we ended up with has three beams, one of which shoots straight forward when the cane is held as a conventional long cane. That beam will go out either to a maximum distance of about 15 feet, or only out as far as the tip of the cane, depending on how you manipulate a little range adjusting rod that sticks out of the side of the cane.

The second beam from the cane looks down obliquely at the ground about three feet from the tip of the cane, so that one can be warned of a sufficiently large dropoff. It can be made to detect a down curb, but that is pushing it to the limit. It would be more conservative to say that it will, under all circumstances, protect the carrier against major catastrophes like open manholes, the beginnings of downgoing flights of stairs, or the ends of subway platforms. Even without a cane, no good blind traveler with adequate hearing would fall off the edge of a subway platform, or at least he wouldn't do it more than once! But an open manhole, an open cellarway, or anything of this sort is another matter. We hope that by giving this extra reassurance the cane will help speed up travel.

In addition to this, another beam points obliquely upward to protect the head and shoulders of the user. Possible danger to them constitutes a rather serious psychological hazard to walking around with just a regular cane, although it's a pretty occasional thing to have one's head banged by a low-hanging tree branch or nearly decapitated by a clothesline. The third beam purports to prevent

---

* Bionic Instruments, 221 Rock Hill Road, Bala-Cynwyd, Pennsylvania.

these unpleasant events. It goes out to a range that ends at a point almost perpendicularly above the tip of the cane, because we have found that a warning in advance of that is not especially helpful.

The electronics are contained in the upper, metallic half of the cane. The upper swelling contains the three lasers. Earlier models of this device took an enclosure the size of a large microphone to contain one light source, while we now have three light sources in this small space between the front and back of the cane. The lower nacelle contains three lenses that pick up the laser light reflected from obstacles and focus that light on photodiodes mounted back here. After suitable circuitry, logic and whatnot, the outputs of the three channels are presented to the user.

The output from the straight ahead channel operates a little poker that is situated where the index finger is placed when one is carrying the cane like a long cane. The other two outputs, the ones that warn of impending disaster downward or upward, warn with auditory cues. A low pitched beep is emitted from a little brass disc in the crook of the cane if a dropoff appears, while a high pitched tone is emitted if an overhang appears. As a matter of fact, if you walk directly into a wall you will also get the high pitched tone, though you will at first have received a tactile stimulus, because the wall is above you as well as in front of you.

This group might be interested in the thinking that went into the human engineering of the cane. The biggest problem was to get something that somebody would use in the first place. The earlier devices that we had made were not in the form of a cane at all, but were the size of a lady's handbag and carried about in one hand. We found that nobody, but nobody, really relishes the idea of carrying a device in one hand and a cane in the other to do what the device can't do. For, in that case, where does he carry his lunch? We adopted the rather modest point of view that the blind traveler wants a cane most. If, besides the cane, he can have a little extra security through electronics, that's great; we'll add the electronics.

Although it is quite an elaborate task to give the blind traveler the necessary electronics to do the three simple things outlined above, we had better struggle to do that and at the same time make the cane pleasing enough that he is going to choose to carry it rather than a more cumbersome cane or a regular cane. For he's not really getting that much more out of the electronic cane. He's getting all warning of things straight ahead, of stepdowns and of things about to bang into his head - three things of real value to him. If he's

going to have to carry ten pounds worth of electronics with him, or get dressed up with batteries in his pocket and an odd hat on his head, or if the device looks very strange and attracts a lot of attention, he is going to say: "The heck with it! I'll continue getting by with my old cane." It was from this point of view, therefore, that we started out.

The cane now weighs more than I wish it did, a pound and a third, about twice that of a conventional Typhlo cane. To get it down to that weight, even, we had to do two main things. Firstly, we made the whole top part, the big, shiny part, of magnesium, as thin a structure of magnesium as we could get and machine. Secondly, we made the thin, painted, bottom part of a special light material, which we'll get into later.

In addition to weight, we were worried a great deal about balance. We wanted to have the balance about where the index finger ends up when one is carrying the Typhlo cane. You don't want it perfectly balanced, because you want it to detect a curb when you are walking along by falling off it. On the other hand, if it's too unbalanced, it will be hard to carry, because that unbalance puts quite a strain on the wrist. For this reason, proper balance becomes a matter of greater concern than minimum weight.

To solve this balance problem, we did two main things. We put all the heaviest things, like batteries, up in the crook to help counterbalance the long moment of the foot. We also decided to compensate for all the weight we had to carry with us by paying very special attention to how we designed the bottom part.

We started out by experimenting with aluminum and magnesium rods to determine which would be better and what thickness of either we could use. We hung pound weights on the end of the cane and measured deflections. What magnesium gained us in lessened weight it lost us in lowered tensile strength and, to be precise, lowered modulus of elasticity as well. So we could have stayed with aluminum, but even aluminum was not terribly stiff and it was still too heavy.

So we started looking around in the aerospace industry, with the thought that some new materials developed for aerospace use might be better. We finally found a composite material, part plastic. A new technique had been developed in which each of the tiny fiberglass fibers, only two or three thousandths of an inch in diameter, that make up a fiberglass reenforced rod is coated with a very thin vacuum plated layer of boron on top of the glass fiber. That stiffens the fiber remarkably, so that if some of them are then laid in helical fashion around a former tube and embedded in a layer of epoxy, the strength-to-weight

ratio of the resulting material is about six times that of aluminum. In addition to using this new material for the lower staff, we tapered it, and by tapering it appropriately we were able to move the center of gravity another two inches higher than it otherwise would be.

We investigated tips. After studying half a dozen different kinds of material for tips, we chose our old friend nylon, the material used in the Typhlo cane. Its use in the Typhlo cane seems to have not been just a fortuitous choice, for nylon seems to have many of the virtues that a tip should have.

Finally, we worried about the covering of both the upper and lower parts of the cane. A cane, after it has been used for about a month, looks like it has gone through the Boer War. We found a new material made by the Minnesota Mining and Manufacturing Co. which is a very sturdy and rugged epoxy with a pebbly sort of feel. We coated the bottom with that and planned to coat the top with it also. We didn't on this prototype because we thought that it would destroy the kind of appearance we wanted if we had to get into it five or six times, as we often tend to do on prototypes.

We were concerned about the carryability of the cane and wanted to put at least one joint in it, so that one could conveniently stow it away under a restaurant table. We worried about how to make a simple joint that would do this. We ended up with a short stub or round cross-section at the bottom of the top part, with two black lines on it. Those black lines are rubber O-rings set in grooves cut into the solid magnesium. This stub slides into an aluminum ferrule inside the epoxy outer shell connecting with the rest of the bottom part of the cane.

We feared that this joint might not transmit high frequency vibrations from the tip of the cane into the upper part, vibrations that help give a good feel to the whole cane. So we made two or three experiments. The experiment that we had made with an earlier cane was to make this kind of a joint, drill a couple of holes in it and then run set screws in it to short circuit the rubber. We let people try it with the screws in and with them out to see if they could tell the difference. Nobody could, including people that were used to working with canes. I confess that it is this sort of seat of the pants of engineering that we have been practicing, and it's on that basis that we picked this variety of joint.

We had thought we would have liked to have had tactile output for all three of our channels. The amount of information we are trying to transmit is extremely small and being transmitted at a very low rate. We certainly didn't want to tie up a valuable ear channel for just the little bit of information that is coming

through. The tactile form of output seemed to be perfect for that purpose. However, there were a couple of practical problems.

Firstly, there was a problem in putting three tactile stimulators next to each other. If one is going to practice the long cane technique, the index finger is pretty well bound to one position. So I would not feel too badly about having the stimulator poke the ball of a finger that had to be held captive because of somebody else's ideas. But to force the finger to not be able to move sideways because there are two other stimulators on it would be putting on some rather serious restraints. This would tend to be fatiguing after a while.

Secondly, three tactile stimulators take up three times the space and three times the power of one. I didn't like that, either. So we decided to cheat a little bit on this first model. We put in one tactile stimulator for the output we considered the most important, the one warning of obstacles straight ahead. For the other, occasional outputs, we used aural ones. It turned out afterwards that this was a good decision; however, I didn't think it through beforehand. It just happened, but, having happened, I would now prefer it. For the aural stimulus is much more attention-getting than the tactile one. Therefore, for these other two situations, which are more disaster-ridden than bumping into somebody, it is a good idea to have an aural stimulus, provided it isn't going to happen so often that it attracts too much attention.

There remains yet one more problem, namely, how loud do you set the aural outputs? In a noisy environment the sound must be a lot louder than in a quiet environment to be heard. In a quiet environment sound loud enough for the noisy environment would attract more attention than necessary. We solved this problem simply and sloppily. We put a volume control in the side and let the user decide for himself.

There is a more sophisticated solution that we have in mind, should our bluff be called. We have designed a small transmitter that can fit inside the cane and a little radio receiver that can be built into a pair of glasses like a hearing aid. Thus we can move the sound directly to the ear of the user without wiring him up. We haven't built this beyond the breadboard stage because we ran out of time and because it didn't seem nearly as amusing afterwards as while we were doing it. If somebody wants it, it can still be done.

We are building seven of these canes altogether and hope that they will be completed sometime this spring. At that time the Veterans Administration will place them. Some of them, at least, will go to Hines for evaluation in the hands of mobility trainers.

Where we go from here is anybody's guess.

TRAVEL PATHSOUNDER

Lindsay Russell*

The travel pathsounder is a small portable air sonar intended for use by cane travellers. It is worn on the chest by means of a neck loop, and its purpose is to probe the volume immediately in front of the user's face and chest and warn him of objects within six feet that pose a collision threat. It is about the size of a tourist's camera.

The warning is an audible one and has the following form: clear path to beyond six feet, no sound; object within six feet, first a ticking sound as the object is approached,then a beeping sound as it comes within thirty inches. The use of this range code permits one to tell at once whether an obstructing object is "close" or "mighty close."

The benefit sought from this device is twofold. First, it is to protect the cane user from hazards that the cane might miss or pass under-- the tailgate of an unloading truck, for example. Second, it is to give him advance warning of other pedestrians in his path and help him avoid bumping them or poking them with his cane. .

It should be emphasized that this device is a supplement to the cane and to the techniques of cane travel, and it is not intended that the user discard any tricks-of-the-trade already at his disposal such as the intelligent use of natural auditory cues. In a reasonably uncongested sidewalk environment, a user can often walk many minutes with no signal from the sounder; the instrument acts as a sort of silent partner in the travel process, continuously surveying the space ahead, but making no sound or intrusion when it finds nothing close enough to warrant a warning.

Only a small number of sounders have been made, each embodying improvements over its predecessors. In each case, after street testing of one model, it seemed wiser to make changes in the design rather than to reproduce in any quantity an instrument for which modifications were clearly indicated.

The late John Dupress collaborated with the inventor in this process, sojourning into crowded areas with a sounder - Grand Central Station and the like, in his spare time, reporting difficulties he encountered and making suggestions for changes. Most of the technical characteristics of the latest version (beamwidth, range limit, etc.) result from Dupress' travel experiences

---

* Consultant, Sensory Aids Evaluation and Development Center, M.I.T., 292 Main Street, Cambridge, Massachusetts.

using this technique.

In the fall of 1967, the writer began giving travel lessons to a blind senior at a local university. The youth, totally blind since early infancy, was already a mobile cane traveller, using the Boston subway system regularly and getting about familiar city sidewalks without undue difficulty. This lesson program was the first instance of someone's receiving formal instructions in the use of the sounder. These are some of the questions to which answers were sought out of this program.

> Does this electronic aid do what it is supposed to do: give reliable warning to protect against collisions with people and objects?
>
> Is there much to learn in getting effective aid from the sounder? Could a good cane traveller pick up this new skill on his own, or would instruction be needed?
>
> What are the negative features of its use? Are there psychological snags in this sort of auditory alarm signal that might be objected to by a large proportion of the blind.

Answers, of at least a tentative nature, are as follows, based, it is emphasized, on only some thirty hours experience with one student.

> First, the street travel observations are encouraging. The student, before going into pedestrian traffic, has practiced a routine which, except under certain special conditions, he is to use when he gets a sudden signal as he walks.
>
> 1. Stop.
> 2. If any signal persists a second, turn shoulders to search for an opening.
> 3. If one is found, proceed in the new direction, walking around whatever was blocking your path.
> 4. If signal disappears on its own during the one second wait, proceed in original direction.
> 5. In any event, don't resume full speed until after taking a few steps.

The reason for the one second wait is that should it be a pedestrian blocking the path, the probability is high that he will step aside, having just noticed the cane as the traveller was coming to a stop. The encounter is least awkwardly resolved by letting the sighted person step aside, something

he will do anyway, like it or not, if he sees the cane.

One can walk a few yards behind his blind student for a quarter mile or more on a college campus sidewalk that abounds with students, some going each way, some stopping to talk, to read a bulletin board,etc., and be quite surprised at how infrequently the sounder has to signal him. The visibility of the cane is an excellent collision preventer with the sighted; it diverts far more from the cane-user's path that he might otherwise have bumped than does the sounder. Often the sound of footsteps or voices will warn him to change direction well before the six-foot range point.

Thus the sounder's role is that of backstop; it is a sort of a court of last resort. All of the other elements of safety have their chance first, but if none of them has worked to abort an accident-in-the-making, the sounder's task, at the last instant, is to warn the user to a stop.

As the student progressed, he was taken to areas of increasingly dense traffic, eventually making several excursions into Christmas shopping crowds on some of Boston's busiest streets during the 5 p.m. rush. The sounder appears to be an effective aid on a crowded sidewalk as well as an open one. There are many more "holds," five or six a minute, sometimes, and the travel strategy changes slightly: most holds will break spontaneously and it is best to wait three or four seconds for the opening to appear on its own. Many holds are due to oncoming pedestrians whose view of the cane has been blocked by other pedestrians until the last instant; when they do see it they will get,generally, out of the path as quickly as they can.

There are several psychological aspects of pathsounder travel which are potentially troublesome. For one thing, it is a bit jarring to be buzzed to a stop by an audible signal as one walks. Even if a pleasanter sound than the ticking is used, it must be loud enough and distinctive enough to evoke a response - in short, the signal is still an audible alarm. On the other hand, after seeing enough collisions, ankle pokes, etc. averted, one might observe, somewhat dryly, that the traveller who didn't like being stopped by a ticking sound has the choice of being stopped by something else— in about two more steps!

The other psychological hurdle and, in the writer's view, possibly the most formidable, is that the aid itself does not reveal the nature of the hazard it warns of. Of course it would be helpful to know what was out there when one received a signal; a better travel decision might then be made. What is more important, though, is that the aid never reveals what would have happened had

the user not responded to its signal. Thus the sighted instructor will know how his student was prevented from walking into a man who stopped to light a cigarette or from walking into a ladder leaning against a building, or a daydreaming youth who didn't notice the cane. The blind traveller, however, will know only that in walking along the sidewalk he got a signal on three occasions, executed his walk around, and kept on going. The sounder, then, however it might have benefitted the traveller, has given him no confirming feedback; he won't know the particular details of the "accident that almost was."

From these psychological considerations as well as from some hours of sidewalk training experience, the writer's view is that an intelligent training program will be the key to the effective use of the pathsounder. An instructor's manual is being prepared, obviously a preliminary document at the present stage, but, one that will summarize the things learned from early experience. Some subjects to be covered are as follows:

1. The nature of the ultrasonic reflection process; what kinds of things will and will not evoke a signal from the instrument.
2. Initial sheltered-area drills with single upright posts; locating the post, practicing walk-bys; practicing walk-betweens with two posts.
3. Corridor practise; recognizing "wall chatter" (signals from door frames, knobs, drinking fountains, fire-extinguishers, etc., that occur when one is hugging the wall too closely).
4. Pedestrian drill with teacher simulating a strange pedestrian encountered on a sidewalk or in a corridor. This is a final important phase of "inside" practice (as distinguished from "real-life" practice; i.e., on a city sidewalk or public place). Student should be taught the various common types of pedestrian encounters: oncoming pedestrians who see the cane too late, pedestrians who pass one and cut in front too soon, etc.
5. Street practice. Of all the elements of the training, probably none is so important as the presence of an instructor for the first thirty hours or so of travel on the city sidewalks. He acts as eyes for the learner as well as being his teacher. His job is to explain the source of each signal, whether the cane-traveller's response was optimum, to identify encounters that might

have resulted in collision had the traveller not stopped, etc. The following are a few examples of explanations that the instructor might give during street practice:

"That was a student nailing an acquaintance dance poster to a tree. It didn't look as though he noticed you at all as you walked around him. Did you hear him hammering before you got the signal?"

"That was a lady with a baby carriage. She had passed us when we had stopped to talk at the corner. Then, for several minutes, she was walking about forty feet in front of you at the same speed as you. Then she stopped and went around to check on the baby. She looked up and saw your cane when you were, I would say, about ten feet away and bearing down on them. She could have moved out of your way but there was no possibility of getting the carriage out of your path at the speed you were traveling. She just froze there with a blank look on her face as though knowing she should call out for you to stop but unable to find the right words. At that point you got the signal. Your cane tip was almost under the pushbar when you had come to a stop. You cleared the carriage by about two feet in the walk-around."

"That collision was his fault, not yours. He was walking down the sidewalk reading a magazine he had just bought--not even close to looking where he was going. You did the best you could; you were at a complete stop by the time he bumped. It would have been worse if you had had no warning."

"That hold seemed like an eternity. I could see you were getting exasperated. Actually it probably didn't last over ten seconds. What happened was that the walk light turned green and a busload of people who had just arrived were swarming across the street and cutting across your path. I am sure you could hear all the footsteps and could tell from the choppy sound of the ticks that you weren't just hanging up on a parking meter, but that it was people cutting across in front of you. The best thing you could have done was just what you did: to wait until you got an open path indication and then proceed. If you had pushed your cane out and tried to move forward during the mob scene, someone would probably have stepped on it. Remember it is dark now at 5 p.m. and they don't see the cane until they are much closer."

"Hold up a minute. Don't go any further. There is an open manhole about five steps in front of you. There is a sawhorse straddling it with a sign on top saying 'caution.' Let's inch forward and see if we get a signal from that sign. I was fairly sure we would, but there was the possibility it might not be high enough to get into the beam, and I didn't want to take a chance. Your cane would very likely have found the manhole or the sawhorse, but I didn't want to take a chance there either. You were walking fast and looked as though sudden trouble was the last thing you would have been alert for."

"Could you make any sense out of that one? No it wasn't a group of people. It was a divan! There was a workman in front and one in back, each holding up his end. They were just standing there blocking part of the sidewalk; a third deliveryman was up ringing the doorbell. You got your signal from the middle of the divan first. You turned to find an opening, but you then faced the rear workman and the path continued to be blocked. That was when he said, 'Walk around me, Mac.' You thought he meant in front, so you turned back toward the divan and took a step toward it, in spite of the ticking from the sounder. That brought the divan into the beep zone, and at that you stopped abruptly. That was when both workmen started giving rapid directions to you. I gather that in the confusion that followed, you got the essentials of what they were trying to say, and that was when you turned hard right and walked far enough toward the edge of the sidewalk to clear the rear workman."

The foregoing examples will suggest what is encountered in street practice. (Each has occurred!) They will also suggest the importance of the instructor's role therein: explaining what happened, what might have happened, giving the user confidence in aid that he might never achieve otherwise.

APPLICATIONS AND FIELD TESTING OF THREE MOBILITY AIDS*

John K. Dupress

The following is a summary of what needs to be done:

1. We need to continue what Dr. Leonard is working on to assess mobility capabilities from the performance standpoint. We need to look back at what sub skills there are that relate to this.
2. We need to look at the technical aspects of the devices and measure what they will do purely from an engineering standpoint. That is, what is the acuity of detection by the device? How predicable is its processing of acquired information? How uniform are the characteristics from device to device among a production lot? How reliable are the devices?
3. We then have to relate our technical analysis to performance or changes in performance. That is, what effect, if any, has the device on the blind person's performance of day-to-day mobility tasks?
4. We need to look at problems which the long cane solves not at all or only in part no matter how skillful the training. We need to assess what extra data could be added.
5. We need to consider the various sub-populations of blind people - children, youth, vocationally placeable adults, the aged - and deal with both the totally blind and the partially sighted since the partially sighted may approach total blindness under certain lighting conditions. We need to put what seems to be a substantially disorganized or departmental set of problems into a coherent package. I think we can do it.

The state-of-the-art concerning the three devices we are studying today (the Kay-Ultra aid, the Russell "pathsounder," the laser cane) is such that they aren't a substitute for mobility capability achieved through long cane

---

*The following is a summarized report of the late Mr. Dupress's presentation at the conference.

training or the use of a dog guide. With perhaps the exception of the Kay-Ultra aid, these devices are no at all relevant to dog guide travellers as the dog solves problems relating to step down, change of terrain, and projection collision.

The three-laser cane was initially designed to give additional data in terms of advance warning of terrain changes and abjects — in short, the area which his cane cannot explore. Those of you who are thinking of using this ought to bear this in mind.

There are also some human factor problems which you ought to be prepared to help the designers work out. For example, in addition to searching out the place where he's next going to place his foot, the laser cane user is looking at a distance 12'-15' away and proportionally wider than the cane swing. The person has to get used to paying attention to all of the information which he gets back. It's easy to say this but those of you who have tried the laser cane will have to be rather clever and thoughtful about how you intend to train people with this extra beam width which they really don't want most of the time. How much early warning is meaningful? What kind of signals are best? The kind of signals which are presented may be the right kind, i.e., concentration on tactile presentation for the most frequently occurring objects which the cane will pick up anyway, and use of audition for the real difficult situations which the cane isn't going to pick up. This may be right, but it's up to you to help work out the answers as to whether this approach is the correct one or not. In addition, you must be prepared to come up with some real life travel situations in which the kinds of displays and the persons' reactions to them can be assessed.

The Russell "pathsounder" was specifically intended to supplement the cane in the area above where the cane is looking and to provide early warning of objects and pedestrians or, to put it another way, to reduce the social penalty of striking a person with your cane. Those of you who use this device will in turn, as Lindsay has pointed out, have to be aware of what the device is preventing the person from doing which is either socially awkward or just plain harmful to the blind traveller or others. You can't expect a high incidence of "saves" with the device, so the queston is, should you really use the device only in a crowded situation or should you try to motivate the person to use it all of the time? The answer to the problem is, like other devices, to, if at all possible, try to pick those situations in which the individual gets a reward from learning to do something. This is a very important factor in motivation.

Concerning the Kay-Ultra aid, St. Dunstan's has come up with a training manual about 150 pages long and a set of training tapes. I want to point out on behalf of St. Dunstan's that they do not believe this to be any final version. It's a first go-around on trying to establish a training manual for the sighted person who will work with the blind individual and to provide a set of training tapes on the use of the device. They would like your reactions to this approach. It is a beginning.

CONFERENCE ACTION - THE IMPLEMENTATION OF A COMMITTEE ON ORIENTATION AND MOBILITY

Throughout the conference, discussion returned again and again to the fact that there was an impasse to advancement created by the lack of communication among psychologists, technologists, and mobility trainers. Consequently, it was unanimously decided to create a Committee on Orientation and Mobility to meet regularly to attack this communication gap.

The scope of committee activities includes the following:

1. the establishment of criteria, procedures, and standards for the technical analysis of mobility aid prototypes and the effective relation of these measures to human performance;
2. the identification of applications and population groups for each type of mobility aid;
3. training procedures;
4. scientific measurement of human performance in real-life mobility situations with and without electronic mobility aids (i.e., aids used in conjunction with a long cane or dog), and,
5. evaluation procedures, data gathering and analysis and dissemination of field test data.

Blind subjects in the evaluations would include children, youth, the middle-aged, and the geriatric population. Multiply handicapped and partially sighted persons would also be included.

The committee will meet once or twice a year for a full day. Sub-committees might meet for longer periods or more frequently. All committee members would be exchanging data and assisting in the preparation of publications between committee meetings.

Committee members include:

<u>Mobility Trainers</u>

Jim Acton, St. Paul's, Newton
Eugene Apple, V.A. Palo Alto, California
Jim Cordell, Arkansas Enterprises for the Blind
Bob Eisenberg, California State College at Los Angeles
Bill Goodman, Florida State University
Larry Hapman, Missouri School for the Blind
Mary Hoffman, Industrial Home for the Blind (N.Y.C.)
Jim Kimbrough, Pittsburgh Guild for the Blind
Paul McDade, Fernald School, Boston
David McGowan, State of Connecticut

Kathryn Reilly, Perkins School for the Blind, Watertown, Mass.
Fred Silver, Boston College
Stanley Suterko, Western Michigan University
McAllister Upshaw, Metropolitan Scoiety for the Blind of Detroit
Robert Whitstock, Seeing Eye, Morristown, N.J.
Pete Wurzburger, San Francisco State College

Technologists

Thomas Benham, Haverford College
Malvern Benjamin, Bionic Instruments
Lindsay Russell, Sensory Aids Center, M.I.T.

Psychologists

Emerson Foulke, University of Louisville
J. Alfred Leonard, Nottingham University, ENGLAND
Ed Wilson, The Lighthouse (N.Y.C.)

OTHER PROJECTS SUGGESTED BY CONFERENCE PARTICIPANTS

1. One of the large stumbling blocks for mobility trainers was: having finally been convinced that a device is worth giving detailed evaluation, they are unable to get ahold of one to use (e.g., the Russell "pathsounder," laser cane, Kay-Ultra aid). Means must be found to finance modest production and distribution of these devices.

2. It was suggested that a list of the locations of all Kay-Ultra aids in the U.S. be obtained from Ultra Electronics. In addition, a U.S. distributor should be established if at all possible. SCIENCE FOR THE BLIND offered their services regarding this problem.

3. It was pointed out that the vast majority of people use inferior folding canes. Therefore, although the Sensory Aids Center may not consider its collapsible cane as having reached the perfection needed to put it on the market, it should release it to the public. This would both aid in a more thorough evaluation of the cane, and put a much better cane in the hands of cane users.

Subsequent to the Conference, the Center decided to respond to the recommendation through the production of a lot of 100 canes to be manufactured by early summer 1968. The canes will be dispersed from the Center in batches of ten to the following facilities for further evaluation and field testing:

Boston College
San Francisco State College
V.A. Hospital, Hines, Illinois
V.A. Hospital, Palo Alto, California
Western Michigan University

They will be available in lengths approximate to the specifications of each of the cooperating facilities (i.e., 48", 50", 56", 58").

The above facilities will select suitable subjects from the group of blind that they serve, instruct these persons in the operation of the cane, and administer pre and post (after two months of testing) trial questionnaires. The test period will continue as long as the subject desires and submits informal reports.

Technical custody of the canes will remain with the Center which will conduct a maintenance service for at least a year. Damaged canes will be repaired and returned to the user as soon as possible upon the Center's receiving them.

The rest of the canes will be available to other agencies and to individuals. An individual, to participate, will require the aid of a sighted person to perform the function of an agency.

APPENDIX A

CONFERENCE FOR MOBILITY TRAINERS AND TECHNOLOGISTS

December 14 & 15, 1967
Massachusetts Institute of Technology
M.I.T. Faculty Club
50 Memorial Drive, Cambridge, Massachusetts
Time: 8:30 a.m. - 4:30 p.m.

AGENDA

December 14th

Morning

8:30-8:45 Welcome and brief remarks. J.K. Dupress
8:45-9:05 Development of Mobility and Orientation Training Programs Using the Long Cane. R. Williams
9:05-9:15 Discussion
9:15-9:35 Mobility and Orientation Programs for Children, Youth, and the Aged. D. Blasch
9:35-9:45 Discussion
9:45-10:00 Coffee break and informal discussion
10:00-10:20 Basic Skills Prior to Intensive Mobility and Orientation Training. J. Malamazian
10:20-10:30 Discussion
10:30-10:50 Long Cane Training: Advantages and Problems. S. Suterko
10:50-11:00 Discussion
11:00-11:20 Data Acquisition Through the Long Cane. E. Foulke
11:20-11:30 Discussion
11:30-11:50 Evaluation of Mobility Capability. J.A. Leonard
11:50-12 noon Discussion
12 noon - 1:00 p.m. lunch

Afternoon

1:00-1:20 Lasers As Mobility Aids. G. Dalrymple
1:20-1:30 Discussion
1:30-1:50 The Laser and the Long Cane. J. M. Benjamin
1:50-2:00 Discussion
2:00-2:20 The Sensing Capabilities of the Kay-Ultra Mobility Aid. G. Dalrymple
2:20-2:30 Discussion
2:30-2:45 Coffee break and informal discussion
2:45-3:05 Human Factors and the "Pathsounder." L. Russell
3:05-3:15 Discussion
3:15-3:35 Applications and Field Testing of Three Mobility Aids. J.K. Dupress
3:35-3:45 Discussion
3:45-4:30 General discussion of evaluation and field tests to date of existing mobility aids.

December 15th

Morning

8:30-9:30 Field trials of existing aids in mobility and orientation training centers
9:30-9:45 Coffee break and informal discussion
9:45-12 noon Guide lines for:

1. engineering analysis of mobility aids,
2. analysis of potential applications for specific mobility aids,
3. training procedures,
4. coordinating the application of mobility aids with mobility and orientation training using a long cane,
5. evaluation procedures,
6. analysis of results,
7. recommendations for improvements in items 1-6.

12 noon-1:00 p.m. lunch

Afternoon

1:00-2:45 Short and long range plans involving specific projects to study and implement the usefulness of sensory aids as supplements to mobility and orientation training with the long cane
2:45-3:00 Coffee break and informal discussion
3:00-4:00 Summary and conclusion

DATE DUE
